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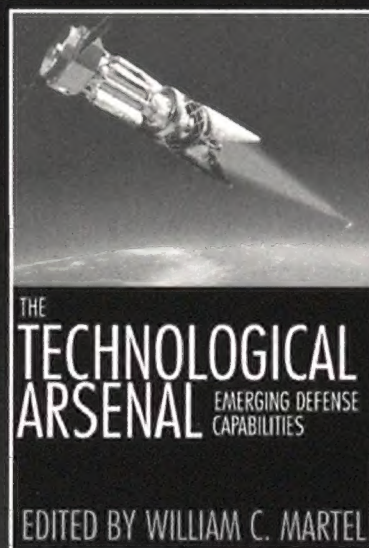
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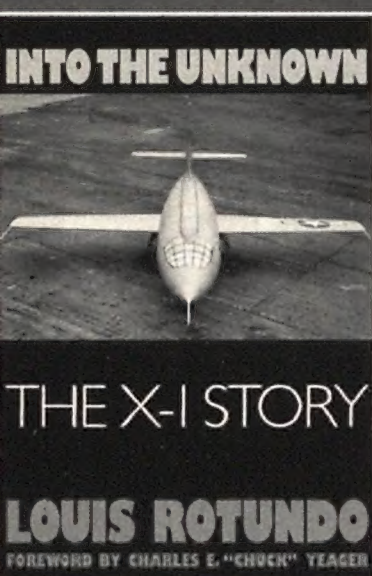
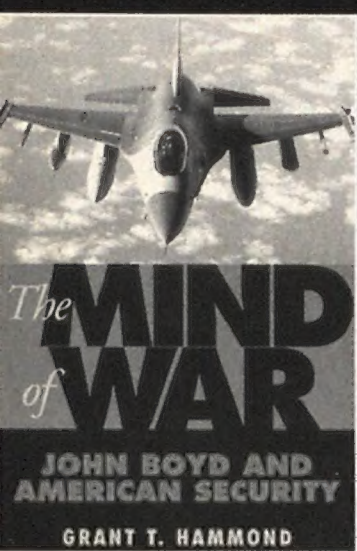
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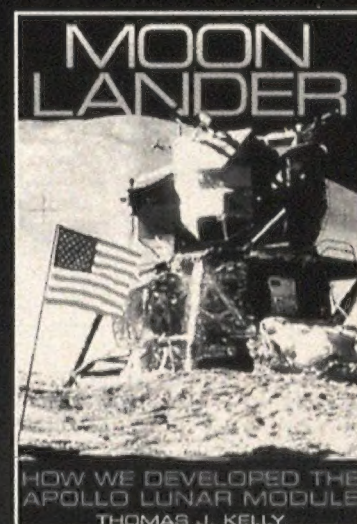
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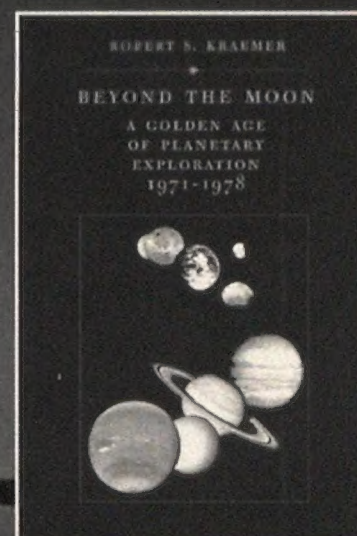
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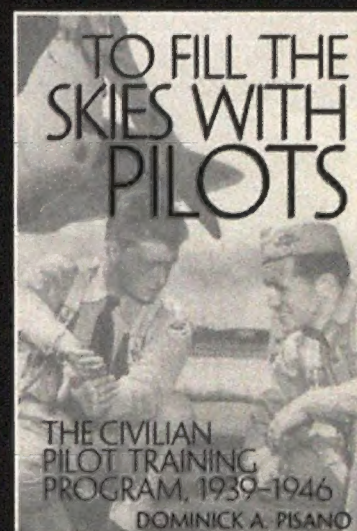
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June/July 2001
Volume 16 • Number 2

FEATURES

- 20 Fallen Star** by Anatoly Zak
A Russian-born journalist penetrates mission control for Mir's final moments.

- 26 Mother** by Preston Lerner
This old B-52 was always there for aircraft needing a lift. You'd think they could call once in a while.

- 34 Reading the Wreckage** by Eric Adams
Photographs by Scott Suchman
How to conduct air catastrophe investigations in about a hundred not-so-easy steps.

- 40 Restoration: Homecoming**
by J. Douglas Hinton
The only authentic Handley Page Halifax bomber in the world is being restored in Canada.

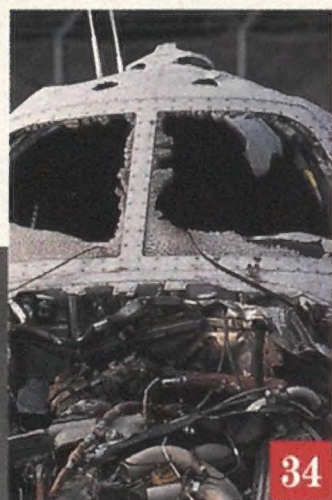
- 42 Strong Light**
Photographs by Cheryl Rossum
When an accomplished portrait photographer takes aim at air- and spacecraft, art happens.

- 48 Fade to Black** by J. Kelly Beatty
Illustrations by Paul DiMare
Old planetary probes never die, they just...

- 54 The Detroit Airlift** by Mark Huber
Photographs by Chad Slattery
Freight dogs do it on short notice.

- 62 Commentary: A More Perfect Astronaut** by Kenneth S. Kosik
Is the next frontier for genetic research the International Space Station?

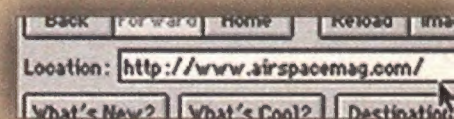
- 64 Dog of War** by Stephan Wilkinson *Photographs by Lance Cheung*
In the early years of Vietnam, the Sikorsky UH-34D was a Marine's best friend.



Cover: NASA's trusty B-52 mothership spreads its wings (185 feet, tip to tip) over the Mojave Desert and under a KC-135, with photographer Jim Ross aiming from the boom operator's pod.

DEPARTMENTS

- | | | | |
|----|--------------------------|----|----------------------|
| 4 | Viewport | 72 | Sightings |
| 6 | Letters | 74 | Reviews & Previews |
| 10 | Soundings | 78 | Credits |
| 14 | In the Museum | 78 | Calendar |
| 16 | Above & Beyond | 79 | Forecast |
| 18 | Oldies & Oddities | 79 | On the Web Site |
| 33 | The Smithsonian Traveler | 80 | Moments & Milestones |



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Original Casting

A few months ago I visited Ken Hyde's enterprise, The Wright Experience, near Warrenton, Virginia. Hyde and his staff restore and replicate historic aircraft and are currently under contract to the Experimental Aircraft Association to create a reproduction of the 1903 Wright *Flyer*, which they plan to fly on December 17, 2003, the 100th anniversary of the original flight at Kitty Hawk, North Carolina.

Hyde and his staff do meticulous research to ensure accuracy. Even the manufacturing methods adhere as much as possible to those used originally. With the help of Tom Crouch and Peter Jakab of the National Air and Space Museum, Hyde's group has assembled one of the finest collections of Wright brothers material in existence.

Here's just one example of how closely their work replicates history: Recently Hyde was testing an original Wright inline, four-cylinder engine (serial number 20, not the one used on the 1903 *Flyer*) with a wooden club in place of the propeller the Wrights used to absorb the engine's power. The club was a simple five-foot stick of maple bolted to the propeller shaft. But when the engine was run, the shaft screwed itself into the club and cracked it. A check of the Wrights' records revealed that the brothers had experienced the same problem. Hyde modified the club, and during my visit I was privileged to watch the start-up and running of this original engine. (You can hear it on www.wrightexperience.com.)

Engine no. 20 had powered a floatplane that flipped on landing and sank. Hyde acquired it in good condition from the grandson of the owner of a

warehouse where it had been stored. Rather than risk damaging it on a flight, he decided to make a copy. All went well until it came time to cast the aluminum crankcase. Every foundry encountered the same problem: "termites," which are small air bubbles or voids in the aluminum. This kind of casting had become a lost art over the years, but the crankcase is such a vital part of the engine that the team couldn't proceed until they solved the problem.

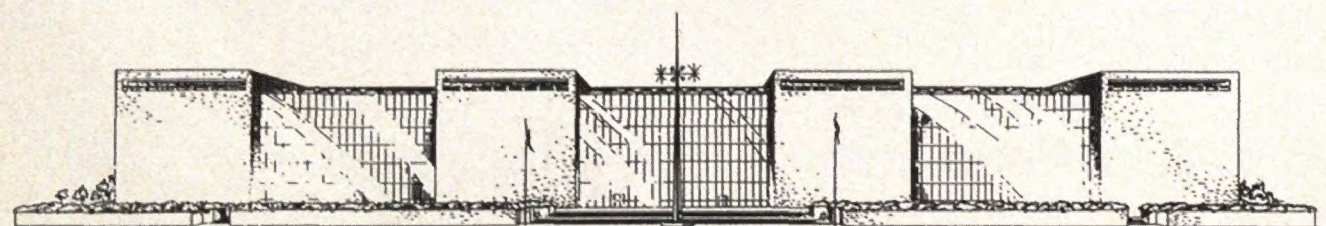
About two months later, the Aluminum Company of America held an evening event at the Museum to honor some ALCOA employees. I was seated next to Alain Belda, chairman and chief executive officer. During the course of the evening I mentioned the difficulty Hyde was having trying to cast a new crankcase. Belda told me there was no metallurgical problem ALCOA couldn't solve and offered his help. I called Hyde the next day with the news, and the casting project is under way.

Talk about serendipity. But it gets better.

The 1949 Engineering Club of Dayton newsletter describing the original Wright engine had this to say about the casting: "The crankcase was made of the then new material aluminum, which was supplied by the parent organization of what is now The Aluminum Company of America, and cast by the Hoban Bros. Foundry in Dayton."

How fitting that ALCOA has reentered the picture at such a critical juncture in Ken Hyde's project. And when the crankcase is complete, it can be said to be a truly original casting.

—J.R. Dailey is the director of the National Air and Space Museum.



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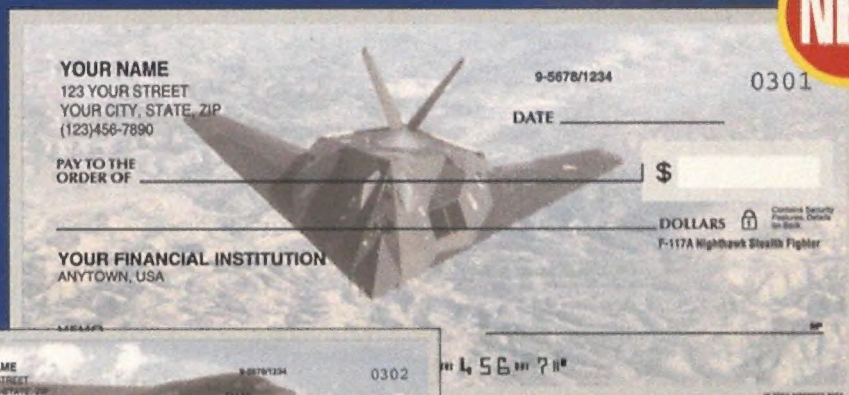


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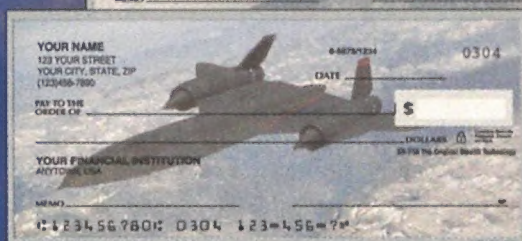
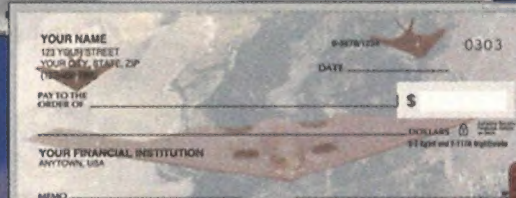
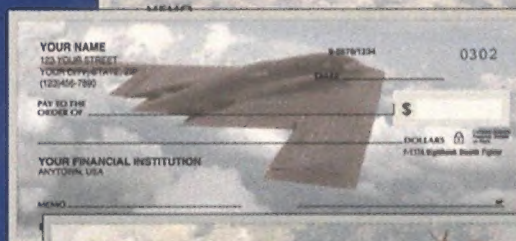
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LETTERS

Ewww! A UAV!

When I read "Predator: First Watch" (Apr./May 2001), I smiled at the observation that seasoned pilots have difficulty flying these things and do not like them. I remembered back many years to when my then-10-year-old son obtained a radio-controlled glider. We went to the top of some hills on the east side of San Francisco Bay, popular with the remote-controlled glider set. My son could make the glider stay up indefinitely and do anything else he wanted. But I, an active private pilot, could not fly the thing! The lesson is clear: The people who should be trained to control unmanned aerial vehicles are the ones who volunteer and want to control them. Perhaps being a seasoned pilot is a detriment. Perhaps those who have more motivation and have not experienced "air under their butt" could do a better job.

—Richard Kennon
Pioneer, California

You folks probably hear similar complaints with every issue, but really, what is that boring camera platform doing on the cover when you could have used the Starfighters instead?

—Rick A. Daugherty
Kennewick, Washington

Reaching for the Starfighter

"The Fastest Show on Earth" (Apr./May 2001) turned on my fond-memory and envy lights. In the 1960s, I was assigned to the Fighter Test Squadron at Edwards Air Force Base. We had 20 or so F-104s for high-speed test support. Most were single-seat A models with a few two-seat B and D models. All were modified for upward ejection (we still wore spurs to prevent leg flail on ejection). The gun, radar, and ammo drum were removed to reduce weight. The result, I presume, would be a configuration very similar to those of the aircraft flown by Rick Svetkoff and Tom Delashaw.

We used the F-104 primarily for high-speed safety and/or photo chase of the YF-12, SR-71, XB-70, and X-15. X-15 pilots used them for survey and for practice approaches to alternate dry lake recovery runways. Lifting body (M-2, HL-10, and X-24) pilots also flew F-104s to practice their approaches. From 45,000 feet, the F-104 with landing gear down, speed brakes out, takeoff/maneuver flaps extended, and power at or near idle provided a

reasonable simulation of the early configurations.

It was also a great traveling airplane. With wingtip fuel tanks, you could go coast to coast at Mach 0.9 above 35,000 feet with only one stop, and with all the original equipment removed there was room for extra main and nose tires, drag chute, suitcase, and even golf clubs. The F-104 was a dream to fly, a fighter you felt you were strapping on rather than getting into.

—Jerry Gentry
Alexandria, Virginia

Editors' note: Test pilot Jerry Gentry was one of the few to fly NASA's lifting body aircraft (see "The Legacy of the Lifting Body," Apr./May 1991.)

From early 1958 to 1960 I was a flightline mechanic for Lockheed Aircraft on the F-104A and B line at Palmdale, California. One of the early maintenance problems was caused when foreign objects were ingested during takeoffs, resulting in damage to the inlet guide vanes and first stages of the rotor and stator blades. Inspection of this area required pulling apart the aft fuselage and engine, a process that was unacceptably time-consuming. Lockheed put out a call for anyone thin enough to squeeze past the spired cones on the engine air inlets. Some of the thinnest people I had ever seen were hired as inspectors, and would literally be shoved down the inlet with a flashlight as part of the preflight inspection. This problem was overcome by a "manufacturing change notice," which required rectangular inspection doors to be installed in both sides of the fuselage just forward of the engine.

—Stanley O. Cunningham
Redmond, Oregon

Your article was interesting to this former F-104 driver, but the accompanying poster contains a major error. You mention "NASA's NF-104s," which featured auxiliary liquid-fuel rocket engines and reaction control systems. Well, the rocket-boosted NF-104s were a project of the U.S. Air Force, not NASA. To be more precise, they were a project of the Aerospace Research Pilot School (now USAF Test Pilot School). The three NF-104s were modified F-104As. ARPS training flights were flown in them from 1968 through December 1971. One NF-104 was lost in 1963 during development testing. The rocket motor blew up on one during a

training flight in June 1971. The remaining NF-104 is on a pole in front of the Test Pilot School at Edwards Air Force Base as a reminder.

—Addison S. Thompson
Palmdale, California

The article makes a single point: The F-104 was pretty much a one-trick pony. The shortcomings of the craft probably were known to the fighter community from the start. They were amply demonstrated in the 1960s, as it was deployed from the United States to places like Spain. In the winter of 1964, I was part of the tanker support of an F-104 deployment from George Air Force Base, California, to Moron Air Base, Spain. The first group of tankers staged out of Altus Air Force Base, Oklahoma. We picked up our flight of five F-104s and headed for Fredericton, New Brunswick. We were running 500 knots true airspeed, which is about what the F-104 cruised at. Still, we refueled those fighters at least eight times on the dash to New Brunswick.

Between 1965 and 1967, the F-104s were flown in Southeast Asia. The United

States had an EC-121 AWACS (airborne warning and control) aircraft orbiting in the Gulf of Tonkin, and it was the job of the F-104s to provide fighter cover for it. The 104s were barely up to the job. They spent most of their time cycling back and forth from their position on station to their tanker. In the summer of 1966, the F-104s were paired with F-4s because the F-4C lacked a gun for close-in MiG engagements. Again, the shortcomings of the F-104 were obvious. The F-4s quickly got on the boom and unloaded their fuel. The F-104s, on the other hand, required a dedicated drogue-equipped tanker, since they had only an external air refueling probe. They took on fuel at a snail's pace, and their underwing drop tanks frequently failed to feed at all. They would return to the tanker two or three times for refueling while the F-4s remained on patrol.

As far as Century series fighters go, the F-105 has it all over the F-104. The Thud is legendary. As a fighter-bomber it has a few MiG kills to its credit; the 104 has none that I know of.

—Gerald P. Hanner
Papillion, Nebraska

Missing Man in Vietnam

"High Honor" (Apr./May 2001) touched me, but failed to mention that during the Vietnam War, the Missing Man formation was flown thousands of times with helicopters, as the pilots honored their own who had fallen supporting the troops on the ground. Most of these were never recorded on film. In particular, one formation, on January 8, 1969, at Soc Trang in IV Corps, stands out like no other. It was for my flight school roommate and close friend, Kenneth Clough, who was killed the day before on his very first UH-1B gunship mission. I have never forgotten him, or the sight of that lone helicopter breaking up and away from the flight, leaving it to carry on with a significant piece missing.

—Paul Christiansen
Olney, Maryland

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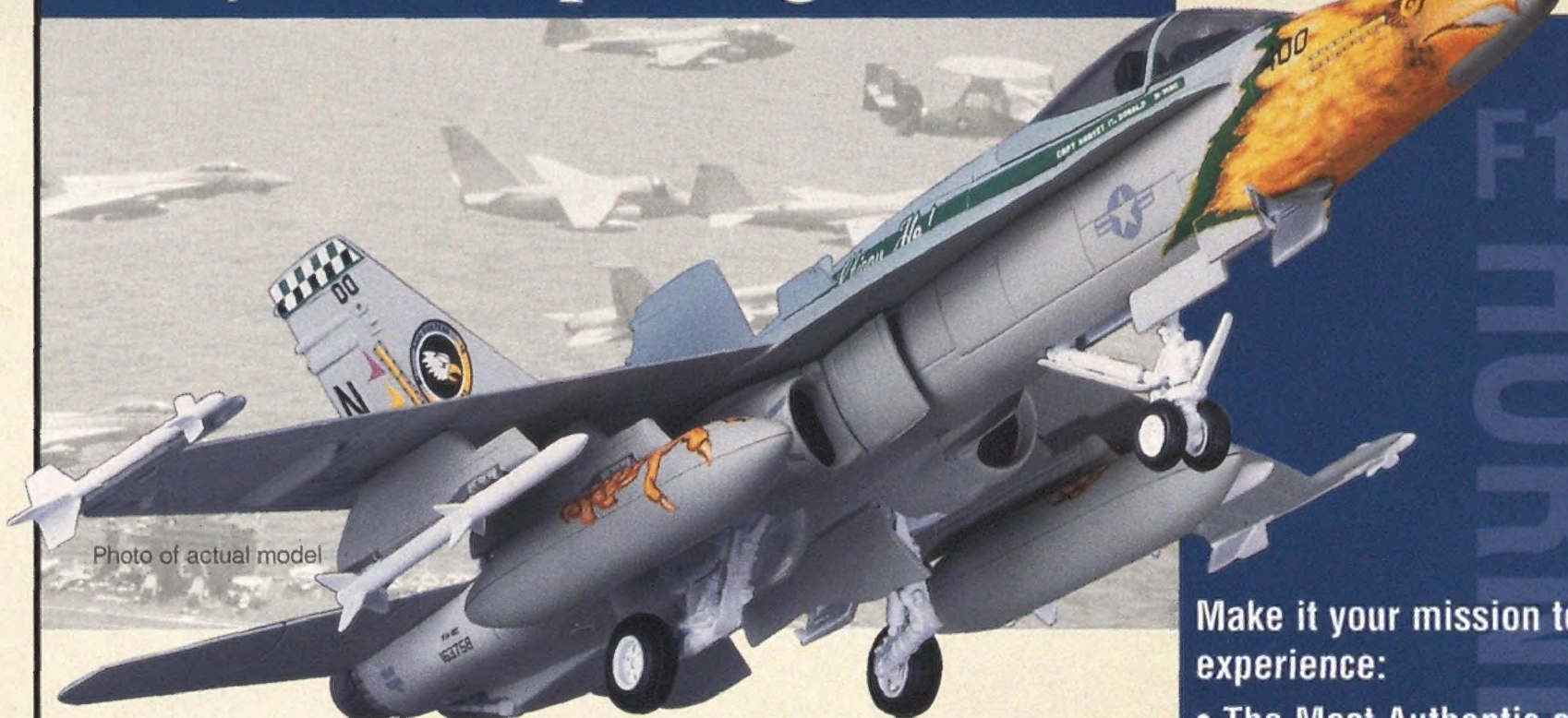


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LETTERS

print an article titled "What Were They Thinking?" (Feb./Mar. 2001), with Alberto Santos-Dumont and his 14-bis featured with some very weird machines, some of which never flew. I do not know if this is arrogance or ignorance, but as an active member of Brazilian aviation societies, I will make sure everybody here knows how you look at Santos-Dumont, a national hero in Brazil.

As a contributing editor to *Avião Revue* magazine, I have tried to show Brazilians the real accomplishments of the Wright brothers. During my research, I became assured that the Santos-Dumont design was totally independent in conception and in the development of passive stability control.

All of us know the problems the Wrights faced when trying to convince their own society and government of their feats. I hope you are not trying to make it up to them, one century later. The world did not delay a second in the recognition of Santos-Dumont's official flights. Down here, we acknowledge the value of both the Wrights and Santos-Dumont.

—Joseph Saab
São Paulo, Brazil

Pikes Not-So-Tall Peak

"Hill Climb" (Apr./May 2001) begins with this: "Pikes Peak, the second highest mountain in Colorado, reaches 14,109 feet above sea level." Though one of the most famous of Colorado's peaks, Pikes Peak is nowhere the near the tallest. In fact, it ranks 31st in elevation among Colorado's 50-plus "14ers," as the mountains over 14,000 feet are known to residents of the state.

—Jon W. Haas
Littleton, Colorado

Editors' note: We should have qualified the statement, which was introduced during editing. Pikes Peak is Colorado's second highest mountain with a road to its summit.

Misplaced Museum

In "Shooting Stars" (Soundings, Apr./May 2001), you refer to the C.R. Smith Museum as being in Dallas. That museum is in Fort Worth, where American Airlines is based. This is a real issue in Fort Worth—that is, national publications putting everything in Dallas.

—David M. Autrey
Fort Worth, Texas

LETTERS

Swiss Reliability

Some people tend to forget that the Swiss are neutral, not pacifist ("Don't Mess With Switzerland," Feb./Mar. 2001). One point that could reinforce the old adage about forgetting the past is the Swiss experience with the Germans in World War II. The article noted that in the pre-war years, the Swiss operated Messerschmitt Bf 109s, among other German aircraft. As a result of the June 1940 fracas your article mentions, the Germans stopped all logistic support for the Swiss' German aircraft. As a result, when the Swiss bought Northrop F-5E/Fs as part of Peace Alps in 1976, they also bought 20 years' worth of spare parts for the aircraft and 10 years' worth for the GE J-85-21 engines, plus a significant depot repair capability. They were not going to be caught short again. Incidentally, the Junkers Ju-85s proved to be very durable. One, believed to be the last on active duty, was a part of the August 1978 delivery ceremonies for the first F-5Es. It was parked next to the C-5A that brought in the F-5s. Quite a juxtaposition.

—Colonel Ken Bowers
U.S. Air Force Reserve (ret.)
Fort Worth, Texas

The article set me to reminiscing about my own fun times with the Swiss. We were some of the first Western fighters to enter an airshow in the Czech Republic after the Wall came down, and we all became friends. We had our own MiG-21 driver as our personal escort. We were out standing by the jets that day, and he kept taking us over to the beer tent for the real Czech Budweiser and shots of schnapps (purely medicinal, of course). One of the Swiss demo teams, a nine-ship of PC-9s, was there too, and every time we ran into them in the beer tent, they would do a quick shot with us, being friendly Swiss guys. About the time my wingman and I were starting to feel a pretty good buzz, I was laughing and swapping stories with the lead Swiss pilot, when suddenly he stopped, looked at the rest of his team, and said, "We must go brief now. We launch in 30 minutes." My jaw just about hit the floor. I had seen French guys put away some wine with lunch, then go fly, and had seen Germans drink some beers at a meet, then go fly a show formation, but 30 minutes later, these Swiss guys were doing nine-ship loops to music while I was having trouble climbing the ladder to give tours of our jet. Now you tell me who the real pros are. Nonetheless, I stayed in a sheltered part of the field until they landed so a rain of burning metal couldn't hurt me.

—Russell Gregory
Danbury, Connecticut

Correction

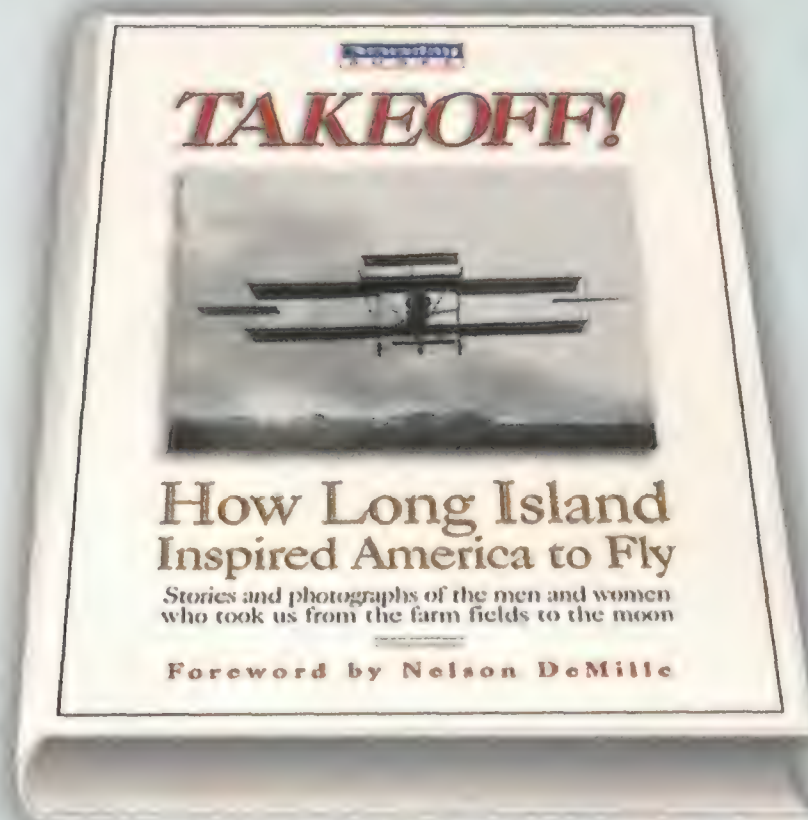
Apr./May 2001 That was not California sunshine in Chad Slattery's cover photograph of the Predator, unless it spilled into Nevada. The photograph was taken at the Indian Springs Air Force Auxiliary Field, adjacent to Nellis Air Force Base.

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Leave 'em Laughing in the Aisles

Aviation and business writers are in mourning these days. They're about to lose Herb Kelleher, the one airline chief who made it fun to write about the business of air transport. Now 70, Kelleher is stepping down as president and CEO of Southwest Airlines.

In the drab world of corporate executives, Kelleher stood out like, well, a guy in an Easter Bunny suit. Or an Elvis impersonator. Or a drum major, a biker, or a drag queen—just a few of the personas Kelleher has adopted over the years in raucous stunts to keep employees motivated, passengers amused, and investors enthusiastic. He famously battled another CEO in an arm-wrestling bout instead of a courtroom to settle a dispute over rights to an advertising slogan (see our Web site, www.airspacemag.com, QT Sightings, "Malice in Dallas"). He appeared in a print ad with a bag over his head. Tall and commanding, with an expressive face, he knows how to play to a camera.

Kelleher's trademarks are Wild Turkey bourbon and Merit Ultra Light cigarettes, which he smokes prodigiously. Will a recent battle with prostate cancer change his habit? Probably not: "I don't smoke with my prostate," he says.

When Kelleher addressed the Wings Club in New York a while back, he spoke of his accomplishments: "I'm here to tell you that I am proud of a couple of things. First, I am very good at projectile vomiting. Second, I've never had a really serious venereal disease."

But woe to any competing airline that wrote off Kelleher as a mere jester. Just ask the former officers of Braniff and Texas International, who did their best to kill off Southwest at birth. Kelleher at the time was a San Antonio lawyer, transplanted from New Jersey, and the plan he hatched with a partner was for a service linking Dallas, Houston, and San



Antonio. It took Kelleher and his team five years, but they finally beat the two intrastate Texas carriers in court, and Southwest began flying in 1971.

By 1973 the startup was in the black, and Southwest has turned a profit every year since. Meanwhile, carriers such as TWA and US Airways have barely hung on, and Eastern, People Express, and many others have fallen victim to failed strategies and pitiless airline economics.

The Southwest formula calls for efficiency in lieu of frills. Forget about assigned seats, inflight meals, and hub-and-spoke connections, but pay low fares. The customer service is enthusiastic and attentive, sometimes even zany—for example, the preflight safety briefing is often sung.

The "Southwest effect" is now an industry phenomenon: When the aggressive carrier enters a market, the competition is forced to meet fares and attempt to match performance. There are 57 cities on the Southwest route map, served by 346 aircraft—all 737s—up from an original fleet of three. Late last April, the airline reported its first-quarter net income was up 65 percent over the previous year's first quarter.

In June, James Parker will take over as chief executive, and Colleen Barrett will

become president and chief operating officer. Their appointments promise continuity: Parker has worked with Kelleher since 1979 and Barrett, who started out as Kelleher's legal secretary, since 1967. Kelleher will remain board chairman of the company at least through 2003.

The newly configured management team has much to contend with. Southwest has long taken pride in its harmonious labor relations and its industry-leading on-time performance. But recently it's had to face picketing ramp workers and a drop from first place to fifth in the Department of Transportation arrival standings. Also, Southwest's competitors are consolidating into mega-carriers, which could make them even tougher to compete against.

Airline analysts, though, remain generally confident in the maverick carrier. "There's still plenty of growth for this company," says Michael Linenberg of Merrill Lynch & Co. He adds that a second tier of Southwest executives who are also stepping forward will do their best to perpetuate what the founder started, "but let's be honest. There's only one Herb Kelleher."

—Lester A. Reingold

Slow and Steady Doesn't Win the Race

"She's a very tired old girl," said British veterinarian Maurice Kirk of his 58-year-old Piper Cub, British registration G-KIRK, when they reached Sydney, Australia, last April. "She's lost a magneto, her fabric's coming off, and just about everything has broken that could."

Their journey along the London-Sydney Air Race 2001 course took them halfway around the globe, nearly 14,000 miles. They flew 200 hours in 28 days, with only a single rest stop in Thailand, and that one given over to oil-sump repairs. G-KIRK was throwing oil, so Kirk doubled the sump's capacity by welding an extension to it. All the other sanctioned rest days were spent catching up with the race, which celebrated a century of Australian federation and re-created the "kangaroo route" air race of 1919. The winner was *Spirit of Kai Tak*, a state-of-the-art Piper Aerostar crewed by four Brits from Hong Kong. Thirty-seven teams left from Biggin Hill near London on March 11, and all but six were on hand for the triumphant fly-past of Sydney Harbor on April 8.

Which didn't include the gallant Piper Cub. G-KIRK was disqualified on the first day, when Kirk landed in a pasture west of Lyons, France, instead of Cannes, the official landing site, to the annoyance of police and race officials. "It was logistics," he later said. "They couldn't cope with the [60-knot] Cub. Or was it Maurice Kirk? I forget which." Nonetheless, Kirk forged ahead, now just along for the ride.

When delivered to the U.S. Army Air Forces in 1943, G-KIRK had a 12-gallon fuselage tank and a range of 190 miles. That would hardly suffice for race days that averaged 500 miles and sometimes double that. Kirk learned that an American had once fitted his Cub with wing tanks from a Piper Colt; the modification had been approved by the Federal Aviation Administration and was therefore legal in Europe.

Now G-KIRK could carry 50 U.S.

HEADS UP

Royal International Air Tattoo 2001

July 28 & 29
Royal Air Force Cottesmore,
Rutland, England

Europe's biggest airshow, the stately Royal International Air Tattoo, celebrates its 30th birthday this summer. Normally held at Royal Air Force Fairford in Gloucestershire, RIAT last year moved to the Joint Force Harrier base RAF Cottesmore, 90 miles north-northwest of London, while runway resurfacing continues at Fairford.

This year's themes are "Women in Aviation" and "Training 2001," highlighting the driving force behind modern air power. And there's air power aplenty at RIAT, which is sort of a Holiday on Ice for the world's air forces. The 2001 cast stars Romanian MiG-21s, the U.S. B-2, German Tornados, Finnish F/A-18s, French Mirage 2000s, Swedish JAS 39 Gripens, Turkish F-16s, Britain's Red Arrows demonstration team, Italy's Frecce Tricolori team, and the Polish air force demo group, Team Iskra. Classic aircraft—B-52, Hawker Hunter, Lancaster, Spitfire, and Hurricane—play supporting roles. Jet-heads can book a spot at the Arrivals and Departures Viewing Enclosure to monitor pre- and post-show traffic. Royal International Air Tattoo, P.O. Box 1940, Fairford, Gloucestershire GL7 4NA, United Kingdom. Phone 44 (0) 1285 713456; fax 44 (0) 1285 713999; www.airtattoo.com.



KATSUHIKO TOKUNAGA

gallons. For a reserve, Kirk cached four plastic jugs in the cabin and snaked a tube through the window to the fuselage tank. In Calcutta, this rig actually put him ahead of the field: airport authorities neglected to send out a tanker of aviation gasoline, and deployed only one tanker the next day. The last contestant didn't get off the ground until 3 p.m. Kirk, meanwhile, refueled the night before with the help of a taxi, a nearby service station, and his jerry cans.

When Kirk set off from Biggin Hill, G-KIRK had sported a wind-vane generator between its landing struts, which powered a 12-volt fuel transfer pump. Alas, the generator failed in Saudi Arabia. Kirk thereafter relied on a hand wobble pump. This in turn failed while G-KIRK was flying across "some sea," as his wife Kirstie described it on their Web site.

The sea was the Bay of Bengal, and Kirk managed to glide down to a Burmese beach for repairs. "They were all in skirts and treated me royally," he reported. "They fed me. It was fantastic."

G-KIRK also made unauthorized landings in Egypt, India, Thailand,

Indonesia, and Australia, further alienating Kirk from officialdom while making him a hero to everyone else. He broke the monotony by occasionally cutting the engine, skimming down to 20 feet above the ground, and shouting to woodcutters or fishermen: "Hi! I'm on my way to Australia!"

Race rules required Kirk to carry a radio and a GPS receiver, which could fix his position by satellite. He preferred his old school atlas, plotting his course between "the pink bits" that once marked the far-flung British Empire.

The East Timor Sea, from Bali to Darwin, was the most difficult crossing: 500 miles, with the wind against him. Kirk got a head start by skipping to the island of Sumba, where he jettisoned his blind-flying gear, spare clothes, and the gifts he'd accumulated along the way.

"Just as the sun began to show itself, I took off against 10 mph headwinds," Kirk rhapsodized by cell phone from Sydney. To minimize the effects of the headwind, he flew 20 feet above the water, which led to a close encounter with two whales. He says he landed at Darwin with 15 minutes of fuel remaining and half an inch of oil on the dipstick.

On the final leg, to Coolangatta, G-KIRK threw two of the six bolts that secured its wooden propeller, which cracked. Happily, Lyle Campbell of Arizona had volunteered to carry a spare prop in his Grumman Albatross, the



ROBERT CARNEIRO

UPDATE

Ex-Planes

NASA has put three space-based X-planes on hold ("The NeXt Generation," Dec. 1999/Jan. 2000). The agency has stopped funding the X-33 and X-34 reusable launch vehicles, stating that the potential benefits from continued flight testing are not worth the high development costs. In response to Bush administration directives to cut International Space Station spending, NASA will shelve the X-38 Crew Return Vehicle. Work on the X-43 Hyper-X (hypersonic aerodynamics research), on the other hand, continues to rocket along.

second oldest airplane in the race. (Campbell had also underwritten Kirk's \$25,000 entry fee.)

At journey's end, Kirk's principal regret was that police helicopters kept him away from the Sydney Harbor Bridge. (G-KIRK was banned from the fly-past. It wasn't officially a contestant, and anyhow it didn't have a radio adequate for formation flying.) "No one has ever looped that bridge," he marveled. "Can you believe it?"

—Daniel Ford

Summer School Pays Off

Summer students making a long-shot astronomical gamble with the National Science Foundation's Very Large Array have found the first radio emission ever detected from a brown dwarf—an enigmatic object that is neither a star nor a planet but something in between—and their discovery is forcing experts to rethink their theories about how brown dwarfs work.

"What is so cool is that this is research that probably nobody else would have tried to do because of its low chance of success," says Kate Becker, a student at Oberlin College in Ohio. "That made it ideal for summer students—we had almost nothing to lose."

"The radio emission these students discovered coming from this brown dwarf is 10,000 times stronger than anyone expected," says Dale Frail, an astronomer at the National Radio Astronomy Observatory in Socorro, New Mexico. "This student project is going to open up a whole new area of research for the VLA."

The 14 students spent last summer working with NRAO scientists in Socorro. While each student had their own scientist-mentor, they traditionally receive some VLA

observing time for a collaborative project of their own. They sought ideas for their project from the NRAO staff, and, when they asked Frail, he suggested they look at the latest research result from the recently launched Chandra X-ray satellite.

The students went to the Chandra Web site and found that the satellite had detected an X-ray flare from brown dwarf LP944-20. "We did some background reading and realized that, based on predictions, the brown dwarf would be unobservable with the VLA," says Edo Berger of the California Institute of Technology in Pasadena, "but we decided to try it anyway."

The students had been given three hours of VLA observing time for their project. They used an hour and a half of it on the brown dwarf. The next day, they gathered at the NRAO Array Operations Center to process their data and make their images. Berger, who had experience processing VLA data, worked alone in the same room as the other students, who were working together on another computer. Berger finished first and was shocked at the image.

"I saw a bright object at the exact position of the brown dwarf and was pretty sure I had made a mistake," he says. He waited for the others. Ten minutes later, their image appeared on the screen, also showing the bright object at the brown dwarf's location.

"We all got excited," says Berger, who then began breaking the 90 minutes of data up into smaller slices. This showed that the brown dwarf's radio emission had risen to a strong peak, then weakened. That meant that the star had undergone a flare. "Then we got real excited," Berger says. They immediately sought and received more observing time, ultimately capturing two more flares.

The strong radio emission was unexpected because brown dwarfs, according to conventional theories, are not supposed to have magnetic fields strong enough to generate any radio emission. "The presumed internal structure of a brown dwarf will not permit a strong enough magnetic field," says Frail.

With roughly 15 to 80 times the mass of Jupiter, the largest planet in our solar system, brown dwarfs are too big to be planets but too small to be true stars, as they have too little mass to trigger hydrogen fusion reactions at their cores, the source of the energy output in larger stars. After decades of searching, astronomers found the first brown dwarf in 1995, and a few dozen are now known.

"They got very lucky," Frail says. "The thing flared during their observation. Other astronomers had looked for radio emissions from brown dwarfs and not found any. This one flared at just the right time."

—Dave Finley

TRADITIONS

Flying in the Great Hall

Jack Felter, president of the Capital Area Antique Modelers Association, is poised to launch "Flying in the Great Hall," a springtime event for modelers held in the expansive National Building Museum in Washington, D.C., last April. Terms such as Butterfly, Peanut, 10-centers, WWII NoCal fighters, and Old Times Rog flew around the Great Hall, along with dozens of stick-and-tissue model airplanes powered by rubber bands, a few of which inevitably landed on the building's upper balcony and atop the majestic 75-foot-tall columns.



CAROLINE SHEEN

It Was 20 Years Ago Today...

Ted Sasseen remembers April 14, 1981, vividly. That was the day the space shuttle *Columbia* returned from its shakedown cruise with veteran astronaut John Young at the controls. "John bounced it a little bit, but it was really, really good for the first time anybody ever landed that thing," recalls Sasseen, who was Kennedy Space Center's chief shuttle engineer at the time and is now retired. "He ran down the ladder, hopped and jumped around—man, he had found a great new toy and he knew it."

Twenty years after *Columbia*'s first flight, Sasseen and a thousand of his co-workers—many of them still working on NASA's shuttle program—reminisced while chowing down on barbecue with the first crew at a reunion at the KSC Visitor Center, which was sponsored by the U.S. Space Walk of Fame, a foundation overseeing development of Space View Park in Titusville, Florida, where the nation's space history is preserved in art and sculpture. Bob Crippen, Young's partner in the cockpit and now the boss at booster maker Thiokol, told the crowd, "We got to do the fun part, but you made it happen."

To hear the reunioners tell it, they thought it might never happen. Sam Beddingfield joined a think tank that started working on the shuttle just days after the crew of Apollo 11 returned from the moon. "I learned that you can think for a loooong time, because from 1969 to 1981 was a long time," he said.

It was March 24, 1979, when Rockwell International delivered the orbiter to KSC. The winged spacecraft reminded Sasseen of "a Fred Flintstone cartoon," with so many heat shield tiles loose or missing from its belly. Each of the 31,000 delicate tiles needed a precision refit—a job that kept 400 "temporary" workers employed at night and on weekends for almost three years, according to the old tile czar, Ernie Reyes. "These were kids in college, housewives and teachers and others, and when they went to work, the engineers themselves didn't know what they were doing with ceramics and tiles," he said. It was like trying to assemble a jigsaw puzzle on a ceiling, he added, and "these folks who gave up their real lives to work out there have never been given enough credit. Power to the puzzle people!"

After 645 days in its processing and assembly hangars—preflight work takes a tenth as long today—the shuttle made it to Launch Pad 39A on December 29, 1980. *Columbia* finally took wing at 7 a.m. EST, April 12, 1981, two days after its first attempt to leave the Florida nest was thwarted by a computer glitch.

The mission was straightforward—to accomplish a launch into orbit and to return to Earth for a landing, and to verify the performance of the entire vehicle (orbiter, solid rocket boosters, and external fuel tank). *Columbia* traveled more than a million miles and spun 37 circles around the planet. A little more than two days and six hours after taking off, the orbiter touched down at Edwards Air Force Base in California.

UPDATE

Back in the Saddle

The last two Martin Mars bombers have resumed their role as firefighters ("Last Call for the Martin Mars?," Soundings, Dec. 2000/Jan. 2001). After Weyerhaeuser confirmed its decision to pull out of the Forest Industries Flying Tanker consortium last summer, TimberWest Forest, the other partner, said it was unable to bear the \$2.2 million (Canadian) yearly cost of the Mars program alone.

After no other companies came to the table, the bombers were readied for hibernation and 20 FIFT personnel were dismissed. However, at the end of March, TimberWest management suddenly announced that the company would pay the entire cost of the FIFT program for the 2001 season, and that it would be business as usual in the 41st year of the Mars' firefighting career in Vancouver, British Columbia. Says reporter Darrell Ohs, who brought this story to our attention, "Sproat Lake without the Martin Mars would be like Egypt without the pyramids."

With *Columbia* being readied for its 27th mission, a service call to the Hubble Space Telescope later this year, Young—still in top management at the Johnson Space Center—was looking to the future. "You all are very lucky to have this good ol' space shuttle down here," he said, "because I sincerely believe that it'll still be flying around 2030."

—Beth Dickey

COLLECTIONS

Tom Reilly's Flying Tigers Warbird Restoration Museum

231 North Hoagland Boulevard
Kissimmee Municipal Airport
Kissimmee, Florida 34741
(407) 933-1942
Open daily 9 a.m.–5 p.m. \$8 Adults, \$6 children
www.warbirdmuseum.com

A half hour from the antiseptic fantasy worlds of Orlando's theme parks is a place less manicured but more grounded in reality. Tom Reilly's Flying Tigers Warbird Restoration Museum is not your typical air museum, with exhibits encased in glass and airplanes encircled with velvet rope. Visitors squeeze between wingtips and fuselages and walk past shelves of scrounged airplane parts to watch as professionals restore vintage aircraft to airworthy status. They gawk into the nose of an F4U-4 Corsair, cavernous without its engine; marvel at the skeleton that gave the B-17 its legendary strength; and inspect a menacing Focke-Wulf Fw 190. Each is a restoration project commissioned by a private owner who has contracted with Reilly's 26-year-old restoration company. Day after day the mechanics labor, their power tools sometimes drowning out tour guide Rich Bozarth's spiel. Periodically these mechanics teach their techniques to the public at five-day, \$995, hands-on Warbird Restoration Schools.



Besides watching the mechanics, visitors can examine a deHavilland Vampire DH-100, Fouga Magister, and Stearman PT-17. An Aeronca C-3, Kreider Reisner KR-34, and Taylorcraft L-2 are suspended from the rafters. Static displays include an LTV A-7 Corsair II, a Lockheed F-104 Starfighter, and a Grumman F9F-7 Cougar. Sign up for a flight in one of Warbird Adventures' two SNJs, or just sit on the wooden deck and savor the sound of a radial engine in full song.

—Stan Solomon

Over 50 and Fabulous

On the morning of November 20, 1953, A. Scott Crossfield became the first pilot to fly at Mach 2, twice the speed of sound. He accomplished this feat in the experimental air-launched, rocket-propelled Douglas D-558-2 Skyrocket number 2. The swept-wing research aircraft attained Mach 2.005 (1,291 mph) at 62,000 feet while in a shallow dive. Seconds afterward, the airplane's XLR-8 rocket engine exhausted its fuel supply and shut down. Crossfield glided earthward to a smooth dead-stick landing on Muroc Dry Lake at Edwards Air Force Base in southern California.

D-558-2 number 2 would go on to make a total of 105 research flights, setting several records in the process. In 1961, the aircraft was transferred from the U.S. Navy to the Smithsonian Institution, where it underwent a 10-month restoration, completed in 1973, to arrest and repair patches of rust and corrosion and to drain water trapped in the magnesium alloy fuselage. The Skyrocket has been on display at the National Air and Space Museum since it opened in 1976.

Number 2 was one of six D-558 research airplanes ordered by the U.S. Navy from the Douglas Aircraft Company for obtaining aerodynamic information at transonic and supersonic speeds. The Navy issued a letter of intent to Douglas on June 22, 1945, for construction of six D-558 aircraft, all possessing straight and thin wing and tail surfaces and turbojet propulsion. Development of the aircraft began under the direction of chief engineer Edward H. Heinemann. Subsequent analysis of captured data on wartime German swept-wing research, combined with swept-wing studies by U.S. scientist Robert T. Jones, pushed Douglas and the Navy to modify the D-558 contract by canning three of the planned aircraft and replacing them with three swept-wing vehicles powered by both turbojet and rocket engines. The first three aircraft, each powered by a single General



The Douglas D-558-2 Skyrocket number 2 was fully restored in 1973. Twenty years earlier, the Skyrocket became the first aircraft to fly at Mach 2. After launch from a U.S. Navy Boeing P2B-1S (opposite), the aircraft's rocket engine ignited, generating 6,000 pounds of thrust on a fuel of liquid oxygen and ethyl alcohol.

Electric TG-180 turbojet, became known as D-558-1 Skystreaks. The last three, powered initially by a Westinghouse J-34 turbojet for low-speed flight plus a Reaction Motors XLR-8 rocket engine for high-speed research, became known as D-558-2 Skyrockets.

The D-558-1 and D-558-2 greatly differed from each other in detail design, and there was little commonality between them, although both took off from the ground. Because of its engine type and airframe design, the D-558-1 was limited to approximately Mach 1. The more powerful D-558-2, using a 6,000-pound-thrust rocket engine fueled with liquid oxygen and diluted ethyl alcohol, could easily exceed Mach 1. The safety hazards of operating a heavily loaded rocket-propelled airplane from the ground later caused Douglas to modify D-558-2 numbers 2 and 3 for air launching from the bomb bay of a converted Boeing P2B-1S (U.S. Navy B-29) Superfortress. At the same time, Douglas modified number 2 for all-rocket propulsion, storing additional fuel in the

space formerly taken by its turbojet engine. Thus modified, number 2 was flown in a high-speed flight research program run by the National Advisory Committee for Aeronautics (NACA).

The D-558-1 and D-558-2 were of mixed aluminum and magnesium construction. Both types featured nose sections that could be jettisoned to serve as emergency escape capsules, and both were designed to carry heavy instrument loads for flight research. The first two D-558-1 Skystreaks were bright glossy red overall, but D-558-1 number 3 and later D-558-2 Skyrockets were glossy white, which proved more desirable for optical tracking purposes.

The first D-558-2 Skyrocket, bureau number 37973 (NACA 143), completed its initial flight on February 4, 1948, piloted by John F. Martin. The second Skyrocket, bureau number 37974 (NACA 144), was used by the NACA to investigate the behavior of swept wings. During this program, before its conversion to all-rocket propulsion, D-558-2 number 2 revealed that swept-

June 13 Exploring Space Lecture: "Clues From the Geologic Record of Mars." Robert Craddock, a geologist with the National Air and Space Museum's Center for Earth and Planetary Studies, will discuss competing interpretations of the complex geologic history of Mars. Einstein Planetarium, 7:30 p.m.

June 16 Family Day. How Things Fly gallery, 10 a.m. to 3 p.m.

June 30 Monthly Star Lecture: "Astrobiology and the Evidence of Life in the Cosmos." Harold Geller, a professor at George Mason University, will explain the science of astrobiology, the study of possibilities for life elsewhere in the universe, and report on the latest findings in the scientific community. A telescope observing session will follow the lecture, weather and time of sunset permitting. Einstein Planetarium, 6 p.m.

July 1 This date marks the beginning of the National Air and Space Museum's year-long 25th anniversary celebration. A day-long birthday party, with activities for all ages, will begin at 10 a.m. Call (202) 357-2700 for more information about the party and other anniversary activities.

Daily Activities

Highlights of Flight. Explore the Museum—from the Wright *Flyer* to the Space Age—through docent-led tours. Information Desk, 10:15 a.m. and 1 p.m.

Forces of Flight and Paper Airplane Contest. Science comes alive during these staff-led demonstrations in the How Things Fly gallery. Daily schedule posted at gallery entrance.

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ERIC LONG



NASM

wing aircraft tend to pitch up under certain aerodynamic conditions.

The NACA used the third D-558-2, bureau number 37975 (NACA 145), in a program evaluating the effectiveness of wing slats and leading edge devices, and examined its behavior with external stores mounted beneath its wings. All three Skyrockets were retired from flight operations in 1956. At one point, Douglas

considered developing a D-558-3 hypersonic research aircraft, upon request of the Office of Naval Research, but this aircraft remained a paper study.

—Richard P. Hallion

Adapted from Aircraft of the National Air and Space Museum, edited by F. Robert van der Linden, Smithsonian Institution Press, 1998.

Launch the Fleet!

Rain showers were the only sign we'd had of tropical storm Earl, brewing in the Gulf of Mexico in early September 1998. Now the weathermen were telling us the storm had grown stronger and was heading for the Florida panhandle.

The radio was saying the storm would pass very close to Tyndall Air Force Base, where the 80-plus F-15s of the 325th Fighter Wing were parked. But we'd just been through a storm watch two weeks ago with Hurricane Bonnie, which had veered northeast at the last minute, and our sense of panic over an impending storm had been considerably dulled. However, in the squadron operations building, on the grease board that ordinarily listed the day's flying schedule, there was now a terse notice: "Hurricane meeting 1000." Our squadron operations officer came scurrying down the hall telling all pilots to go home and take care of their houses and families. When we returned for the 1000 meeting, we were to have our bags packed and be ready to "hurevac."

Hurricane evacuations became a high priority after Hurricane Andrew devastated Homestead Air Force Base—and much of Dade County—in 1992. The purpose of a hurevac is to fly all of the base's aircraft out of harm's way. Most bases do not have enough hangar space to protect all the air wing's aircraft. The only option is to take them where the storm isn't.

Pilots are torn between the excitement of deploying at a moment's notice and concern for the family they'll leave behind. Most families have hurevac plans of their own. When the jets leave, the family members load up the car and drive inland a hundred miles or so. These plans usually suffer the same fate as the Air Force plans to evacuate. Disbelief is rampant until the storm's effects begin to be felt. By then it's a toss-up as to whether it would be safer to stay put or risk

driving through the heart of the storm.

This was the case with Hurricane Earl, which was originally slated to make landfall near New Orleans. At the 1000 meeting, the operations officer told us tropical storm Earl was indeed heading our way. The wing commander would watch its movement for another hour and then decide if we would hurevac.

The operations officer began briefing us on our hurevac plan. All three squadrons of 22 aircraft each would

elements with 15-minute spacing to prevent clogging up the air traffic control system. As each aircraft got airborne, it would lock its radar on the aircraft ahead of it. By separating the takeoffs by 20 seconds, we would end up with two miles between aircraft. We could then simply follow the jet ahead of us until we broke out on top of the hurricane—somewhere around 30,000 feet, we hoped. While this is something that we do whenever there is bad weather on departure, as the flight

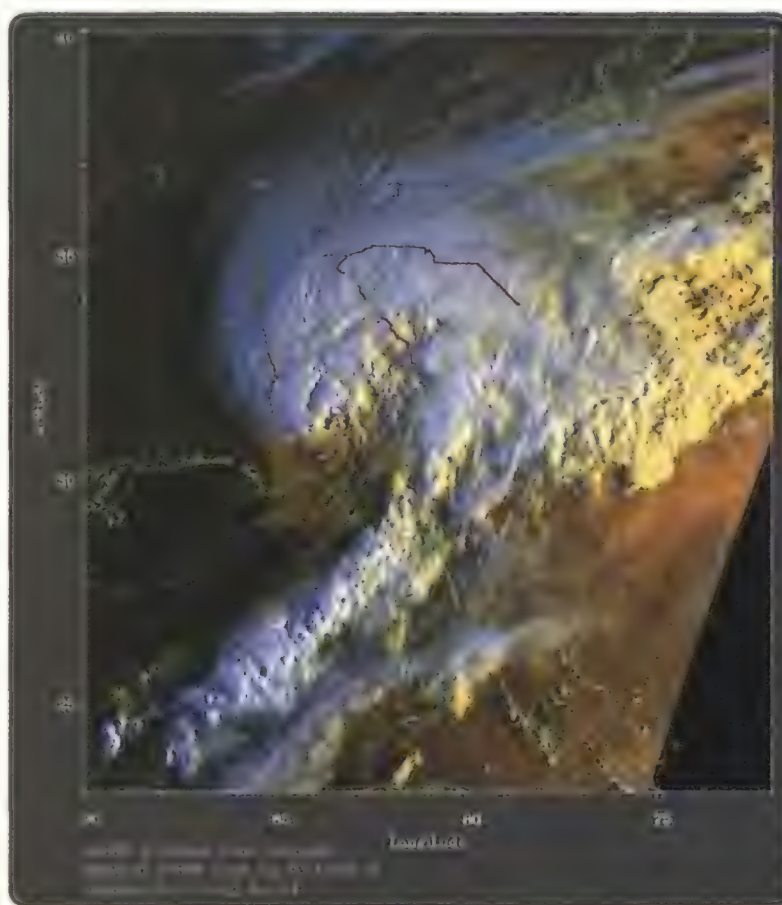
lead of one of the four-ship cells, I spent a lot of time covering contingencies—no doubt the hurricane would make even routine tasks much more challenging. I wanted everyone to be flexible and keep thinking ahead, making sure we didn't do anything dumb, dangerous, or different.

As we arrived back at the operations desk, Earl had just been upgraded to a hurricane and was now projected to make landfall right over Tyndall. At 1100, the word came down: "Launch the fleet."

Maintenance had somehow gotten the word that we were probably going to put most of the aircraft into hangars and ride out the storm. Now they had to prepare the jets to fly, hang external fuel tanks, and gas them, all in 30-mph winds and driving rain.

We anxiously awaited a go from maintenance while we watched the weather deteriorate. Eventually, one four-ship element was ready. A half-hour later, another four-ship was ready. After an hour and a half, our four jets were ready. We got a last-minute weather update from the operations desk and went out to the van taking us to the jets. This would be our last few minutes of calm.

When the van arrived at the flightline, we saw that things weren't going quite as planned. Pilots cowered under the wings of their jets, trying to stay dry as the crew chiefs did final maintenance. For safety reasons, an aircraft cannot be refueled while another is running next door, so the



OCEAN REMOTE SENSING GROUP, JOHNS HOPKINS UNIVERSITY APPLIED PHYSICS LAB

deploy to various Air Force bases. One squadron would go to Wright-Patterson in Ohio. Another would head for Randolph in San Antonio, Texas. Our squadron was to go to Tinker Air Force Base in Oklahoma. A squadron of F-15s from Royal Air Force Base Lakenheath in the United Kingdom, in town to practice shooting live missiles, would evacuate to Otis Air National Guard Base in Massachusetts, the first stop on their long trek home.

The plan was to take off in four-ship

crew had to ground-check the running jets, then move them out of the way while the rest of their flight got ready.

The carefully laid plans of matching experienced pilots with inexperienced ones quickly gave way to elements being flown by whoever had an aircraft ready. Soon the roar of departing aircraft overcame the battering of the rain on the canopies, and the flightline began thinning out.

As soon as my jet was ready, I hopped up into the cockpit and cranked the engines. The cockpit was a pool of water, and I briefly wondered if any pilot had ever been electrocuted in a rainstorm when electrical power for the aircraft had come on line.

After condensing 15 minutes of ground checks into five, I began checking the status of my flight members. One was having a problem with one of his engines and had called for maintenance to try to fix it. Another wingman reported that maintenance had forgotten to fuel his external tank, leaving him short of the gas needed to make Tinker.

Operations told us to taxi out and plan to depart with the two jets that were ready. They were worried that the weather would go below takeoff limits, trapping aircraft on the ground directly in the path of the storm. It had just about become every man for himself.

As we were getting our last-chance maintenance checks done at the end of the runway, operations reported that two more jets were ready to go. Though they weren't part of our original four-ship, operations wanted them to go with us to get as many aircraft airborne as possible.

After figuring out who was who over the radio, we were ready for departure. The tower cleared us for takeoff as we moved into position on the southeast-bound runway. I was the first of our element to start down the runway and was amazed at how unstable the jet felt in the rapidly changing winds. The combination of the strong crosswinds hammering the F-15's towering twin tails and the reduced stability from hydroplaning on inches of standing water made the airplane want to weathervane into the wind.

As we passed 100 knots, it was taking nearly full stick deflection to keep the airplane pointed down the runway. Forty knots more to takeoff. As the nose gear lifted off the runway, the weathervaning effect intensified. I cut the normal climb angle of 10 degrees in half in a feeble attempt to reduce this effect and build up airspeed a little bit more rapidly.

As the jet finally lurched into the air, the flight controls went all sloppy as they fought against the gusts. Wind shear kept dropping the airplane back down. Should I raise the landing gear for an increased

climb rate or leave it down in case the winds forced me back on the runway?

The rain sounded like a machine gun as I informed departure control that we were airborne. Already, I could hear signs of trouble. One of the jets that had taken off just before us had developed an attitude indicator and heading problem. The pilot was currently flying off the small standby attitude indicator at the bottom of his instrument panel and receiving his heading from his wingman's radio calls.

As departure control handed that four-ship off to a different frequency to work on their problem, I heard the rest of my four-ship call that they were "tied" to the aircraft ahead of them with their radar. I began a sweeping left turn, dragging my daisy chain of fighters toward clearer skies, when number four's radar suddenly broke lock and stopped sweeping. Within seconds, number three's radio stopped receiving. Just before three's radio died, he had heard just enough from four to learn that four was having radar problems. In between three's calls that he was not receiving any air traffic control radio transmissions, he passed his position, altitude, and airspeed to four so that four could maintain an approximate heading and hold an altitude that would not conflict with the rest of the flight.

As my jet buffeted its way up through 30,000 feet, it began to pick up some intermittent icing. I called for our flight to turn on our anti-icing equipment and continued to hear three broadcast his parameters to number four. It was clear from four's voice that everything was under control. As I broke out into clear skies at 39,000 feet, I felt grateful to have highly experienced wingmen.

With my flight rejoining above the hurricane, the mysterious problems began to disappear. Number three's radio began receiving. Number four's radar began sweeping again. It was clear that the problems we had on departure were a result of the torrential rain.

Settling down for the remaining hour of what would finally be an uneventful flight, the conversation turned to lighter topics. Did anyone know a good Mexican restaurant? Anyone hear any reports of a whiskey front blowing toward Tinker Air Force Base?

An hour and a half later, 22 F-15s landed safely at Tinker, and soon we were all settled in a hotel in Oklahoma City. Hurricane Earl ended up clipping the edge of Tyndall, doing no more than minor damage to the base and the surrounding communities—but for some \$2 billion worth of F-15s cooling their heels halfway across the country, it was better safe than sorry.

—Russell Gregory

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The Little Steel Strike Airlift

On the eve of Memorial Day, 1937, in the small Ohio town of Niles, strikebreaking was lifted to new heights. In the skies over Republic Steel's plant, there began an airlift to rescue company employees locked inside during "the Little Steel Strike," one of the most turbulent and bloody in labor's long struggle to unionize workers.

Republic Steel president Tom M. Girdler had created a Maginot Line with other "little" steel companies—Bethlehem, Inland, National, Youngstown Sheet and Tube—to stave off trade union formation by the newly formed Steel Workers Organizing Committee, a branch of the Congress of Industrial Organizations. Big Steel, as the industrial Goliath, United States Steel, was known, recently had agreed to recognize the union. To Girdler, this was nothing less than betrayal and capitulation. He was ready for war. On May 20, he shut down Republic's Massillon mill. Six days later, the SWOC ordered a strike against Republic and Sheet and Tube operations. Strikers formed a heavily armed picket line around the plants, blocking people and supplies from entering and loyal employees from exiting.

After hearing that 2,600 employees were holed up with almost no food or supplies in the Niles and nearby Warren plants, Girdler hatched a scheme to send them sustenance. "We were going to fly it!" he wrote in his autobiography, *Boot Straps*. "Airplanes were the only answer."

The first aircraft to be made available, a Waco biplane, belonged to a company employee. Bread, ham, beans, and canned salmon were packed into padded sacks. On the first attempt, two sacks landed outside the Niles plant fence and fell into the hands of union pickets. But a second drop successfully landed 10 sacks, and Girdler's employees were soon eating.



LLOYD JONES/THE VINDICATOR, 1937

That afternoon, Girdler arranged to buy four used Wacos, the nucleus of a fleet that eventually consisted of seven cabin Wacos and two open-cockpit models. Four of the eight pilots were Republic employees. Flights originated from a secret base, Great Lakes Airport, 50 miles north of the mills. It took 200 workers to unload supplies off a convoy of trucks and reload them onto aircraft. Company representatives tried to get Ashland County sheriff Frank Wallett to deputize workers, but he refused, saying, "That would drag me into it."

Republic was able to keep the whereabouts of its base of operations concealed for a time. Two weeks into the strike, however, the company was denied landing rights by Cleveland Mayor H.H. Burton and forced to seek another airport. A 50-acre private field in Ashland became Republic's new base.

Management ordered a pine board landing strip to be built next to the rail yard at the Warren plant. From dawn to dusk for 28 days, Republic's fleet of Wacos shuttled tons of food and supplies into the factories.

Witnessing a new brand of strikebreaking, the Steel Workers Organizing Committee responded with countermeasures. It sent its own airplanes skyward on "scouting missions" to thwart the airlift—in effect, to attempt an air blockade. Records don't identify the union aircraft, but the *Youngstown Vindicator* reported: "The union planes did a few stunts in the clouds in their 'maneuvers' calculated to frustrate 'enemy' attempts to bring new supplies to the workers."

On the ground, strikers resorted to

violence. Men hid in trees and ditches and opened fire with rifles as the Wacos wobbled toward their destinations. Every landing was a feat. Pilot Frank Groat, an electrician and part-time pilot hired by Republic, remembered volleys of gunfire as he eased his Waco toward the airstrip. "Every now and then you could hear the bullets whizzing by you as you flew into the mill," he recalled from his home in Florida. "We never shut off the engines when we came in. We landed, men came out to unload the planes, and we took off. In Niles they used a big net to catch the supplies when we flew over. On those flights we took a second man along, a 'bomber,' we called him. He threw the supplies out through the door."

On June 2, an open-cockpit Waco slammed into a lumber pile alongside the Warren landing strip, bounced into the air, struck a boxcar, and crashed. One wing was broken off and the landing gear badly damaged. The pilot, who was not identified in the *Vindicator*, walked away with slight bruises.

By June's end, the Little Steel Strike collapsed. The Steel Workers Organizing Committee failed to organize workers and ordered its men back to work without a contract. Ten people had been killed and a hundred wounded in the "Memorial Day Massacre" clash between strikers and police at Republic's South Chicago plant.

Republic pilots had delivered 200,000 pounds of supplies. "In buying these airplanes, in flying food and supplies to the beleaguered plants," Girdler said in *Boot Straps*, "Republic Steel Corporation was simply taking care of its own."

—Robert G. Pushkar

"Our children must know that the future is theirs..."



PHOTO: ERIC LUNG

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—AGNES BROWN

Museum docent Agnes Brown stands in front of the Douglas DC-3 on display in the Museum's Air Transportation Gallery. Her late husband flew this type aircraft during the invasion of Normandy and the Berlin Airlift.

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Fallen Star

THE DAY THE STATION DIED.

BY ANATOLY ZAK

Spring came late this year in Moscow. Mornings in March would greet drivers in the frantic Russian capital with gray skies, a drizzling mix of rain and snow, and roads covered with dirty slush. This was the weather I found the day I landed here for a stay that would include witnessing the end of space station Mir's 15-year mission.

On my way from the airport, I saw a giant billboard towering over a highway. It depicted a spacewalking cosmonaut painting a logo of Java, a brand of Russian cigarette, on the nose of the U.S. space shuttle. A stylized rendering of Mir floated in the background.

I soon discovered that the billboard was one of a series of cigarette ads plastering the city. The entire campaign, unequivocally titled "Strike Back," was colored by anti-American sentiment. One ad showed a Russian bear conquering the peak of the Empire State Building; another depicted a famous Soviet-era monument—a proletarian and a peasant—overshadowing the Manhattan skyline. Yet another billboard portrayed a U.S. astronaut stunned by a gargantuan pack of Russian cigarettes rising up from the surface of the moon.

My Moscow friends believed the entire campaign was actually staged by U.S. cigarette companies, which had



Took a licking and kept on ticking: Over its 15-year history, the Mir space station endured a fire, a crash, political upheaval, and bad crew chemistry—the latter sometimes resulting when the U.S. shuttle delivered astronauts to team up with the station's cosmonauts for joint missions.

bought a stake in the Russian tobacco industry. To me, though, the blunt images also seemed to be a sign that on the eve of Mir's demise, Russia's national pride was aching.

Whatever the case, the deorbiting was taking place at a time when U.S.-Russian relations were not particular-

ly good. Along with coverage of Mir, Russian television news was running stories about an espionage investigation leading to the expulsion of Russian diplomats from Washington and Americans from Russia, as well as reports on upcoming contacts between the U.S. Department of State and

Chechen separatists, who had recently hijacked a Russian airplane, an act that had ended with a Russian flight attendant being killed. And days before Mir's deorbiting, NASA increased its opposition to the flight of Dennis Tito, a U.S. businessman who had paid some \$20 million to the cash-strapped Russian space industry for a ride on a Soyuz spacecraft and a short stay on

Moscow. There, at the age of 18, I was doing my first year of compulsory service in the Soviet army. On February 20, 1986, I was sitting in the base's closet-like post office, sorting mail, when a friend stopped by to check for letters. "By the way," he said, knowing my interest in space, "we just launched the new space station called Mir.... They said on TV the thing has six dock-

ing ports!" Back then, we had grown accustomed to the space program being surrounded in secrecy, so the release of this information—a sign of Mikhail Gorbachev's *glasnost* policy—was unusual. I could picture Mir as a cluster of modules, with transport ships shuttling between the station and Earth.

Less than a month later, I saw live coverage of the launch of a Soyuz T15 carrying the station's first crew, Leonid Kizim and Vladimir Soloviev, to a brand-new Mir.

Over the next 15 years, the Russians made 28 expeditions to the station. Except for a short break in 1989, Mir was continuously inhabited from 1987 to 1999. That August, a cash-strapped Russian government decided it could no longer pay for more expeditions.

One privately financed trip to the station was conducted in 2000, but for the most part, Mir passed its final months unmanned, its systems slowly deteriorating in the absence of maintenance. Finally, in the second half of 2000, officials from RKK Energia, the company that built and operated Mir, decided to deorbit the outpost while it was still under control.

To the Communist representatives in the Duma, the Russian parliament,



COLLAGE: ANDREW FAULKNER STUDIO; SOVFOOTO/EASTFOOTO/TASS PHOTOS

the International Space Station.

On the night of March 23, I climbed into a beat-up cab and headed northeast along the Yaroslavl Shosse, a wide and straight freeway that during work hours carries a roaring flood of cars and trucks to and from Moscow. Now the vast road was empty, and sparkled with drizzle. As I looked out the window, my thoughts turned to Mir.

I remembered a cold winter day at a military base hidden in the midst of evergreen woods 500 miles north of

it was clear that Russia's
national pride was aching. The deorbiting was taking
place at a time when U.S.-Russian relations
were not particularly good.
On the eve of Mir's demise,

the abandonment of Mir was a form of treason. In the week preceding Mir's reentry, they called for a vote of no confidence in the government of President Vladimir Putin, citing, among other things, the decision to deorbit Mir. (The proposal did not pass.)

Die-hard defenders of Mir staged demonstrations before the Moscow City Hall, the headquarters of the Russian Aviation and Space Agency, and the mission control building in the town of Korolev. Throughout Moscow, everyone from taxi drivers to TV stars seemed to have an opinion about the events taking place 130 miles up. Everyone had a plan for saving Mir and with it, Russia's stature as the leading space power.

Widely publicized proposals ranged from parking Mir in a higher orbit until better economic days to launching a new Mir-2. The latter idea received a lot of attention in the Russian media, since it apparently originated in the Duma. However, the money for such a project had yet to be found; one popular Moscow TV comedian joked that Mir-2 would be built on the bottom of the ocean, so it would never need to be deorbited.

Despite the multitude of opinions, in the attitude toward their space program, the Russians seemed to be falling into two irreconcilable camps—much like the division that 19th century Russian writer Ivan Turgenev once characterized as “fathers and sons.”

Mikhail Kirushkin, a veteran of mission control's public affairs office, held views very similar to those expressed by Communist representatives in the Duma. He saw the space program heading for a gloomy future. “The hole we are falling in has no bottom,” he said to me. “We will continue going down as long as present authorities stay in power.” Kirushkin believed that rampant corruption in the Russian government, combined with what are perceived to be efforts by the United States to squeeze Russia out of the International Space Station, has already doomed the national space effort. “Essentially, we are serving the U.S. space program, and Americans will throw us out as soon as they get from us the hardware and

experience they need,” Kirushkin said.

In contrast, the younger generation of Russians, while accepting the realities of today's Russia, sees the situation less pessimistically. Sergei Kazulin, a former classmate of mine at Moscow State University, said: “Our independent spaceflights are over. International cooperation in space, and launches that our economy needs, will go on. The space program still remains a ‘holy cow’ in our society; our public opinion has always said ‘Don't dare kill the space program.’”

arched entrance. This was mission control center, known by its Russian abbreviation: TsUP. Since it was completed in the mid-1970s in anticipation of the Soyuz-Apollo docking mission, it has served as the façade of the Russian space program, one of the few facilities in the program open to foreigners and the press. For many years, countless dignitaries and journalists had gathered here to witness crucial launches, dockings, and landings.

The parking lot and adjacent curbs were already jammed with cars. In the



The deorbiting of Mir was only part of a hectic scene the author encountered at the TsUP control center. Outside, Russian nationalists protested the mission's end while police looked on. Inside, reporters observed mission controllers monitoring screens displaying images reflecting telemetry...

My cab crossed the boundary of Moscow in the direction of Korolev, an endless suburban sprawl of dachas, apartment blocks, and industrial parks. In the darkness we drove along an endless brick wall. Slightly before 3 a.m., we finally reached a windowless, marble-clad building with an

building's vast, sterile, poorly lit lobby, our hosts struggled to process large stacks of accreditation letters and invitations.

Finally I was handed an ID. To my horror, it turned out that its color coding, green, indicated that I was restricted to the International Space Station control room. The amphitheater-

The huge room was completely jammed with officials, photographers, and reporters. On one wall, a screen showed the doomed space station as a shining dot crawling along a map of the world.

gram official, had zero effect on him.

My next attempt to enter the Mir control room, this time through the door of the main floor, was foiled by another guard. "We let in only people on the list," he told me sternly. Someone behind me asked: "Would you let in a cosmonaut?" It turned out to be Alexander Kaleri. In April 2000, he and his commander, Sergei

crowded room, I saw, through the doorway, a staircase on the other side of the room, littered with numerous cables and electronic equipment. Thirty seconds and two flights of stairs later, I entered the balcony of the Mir control room, exactly opposite the militia-guarded entrance. (In Russia, they say, every place has a back door.)

The huge room was flooded with the lights of TV crews and completely jammed with officials, photographers, and reporters. I could see the Mir control floor, and on the main wall a giant screen showing a map of the world. The doomed space station was represented by a shining dot that crawled over the map in a sinusoidal trajectory.

Minutes later, the impassive voice of the commentator announced that the first of three deorbiting engine burns had started. It was 3:32 a.m. Moscow time.

If there was a single person now holding the fate of Mir, it was Vladimir Soloviev, a member of the first Mir crew, who became station operations manager in 1989. In the early 1990s, while working for a daily Moscow paper, I had interviewed him about the future of Russian spaceflight. Soloviev spoke with hope about Mir-2, and about bigger and better transports shuttling between Earth and the future space station.

I had last seen Soloviev only days before, on the same balcony, explaining to reporters the techniques of deorbiting and all scenarios, probable and improbable, that might arise as the 137-ton station dove toward its fiery death. Now he was speaking about upcoming deorbiting operations. When asked if he would be saddened by the loss of Mir, he replied that his team still had a lot of projects to work on. "But what are your personal feelings [about the deorbiting]?" one reporter asked insistently. "My personal feeling is that everything goes as scheduled.... Everybody wants to see me cry," he complained.

On the main control floor, I spotted another major player in the Mir saga: Victor Blagov, who for many years managed the shifts of controllers monitoring the station's systems. When asked the hardest and most politically incorrect questions, he always gave sincere and expert answers, so he was



ALL PHOTOGRAPHS NIKOLAI IGNATIEV

like main balcony of the Mir control room was open only to the lucky owners of blue (guest) and red (specialist) identification cards. A uniformed militia officer stood by the entrance to enforce the distinctions. My desperate pleas to be let in, at least for a short interview of some space pro-

Zaletin, had boarded Mir on a mission advertised as the first in a new era of commercially sponsored spaceflights. As it turned out, the two-month flight, paid for by a group of U.S. businessmen hoping to commercialize Mir, was the station's last.

As Kaleri squeezed himself into the

probably the TsUP official that the Russian press corps respected most.

Blagov was sitting at the back row of the control room, in front of a computer display topped with a sign reading "Flight Manager." On the screen, he watched the telemetry information from the next-to-last burn of the engine of the Progress cargo ship that was docked to the station. This maneuver would send Mir into its final orbit around Earth.

As several of his associates flocked around, Blagov leaned back in his chair, his pose suggesting "Look ma, no hands." As if to confirm his confidence, the flight commentator reported that the orbit correction maneuver had succeeded and all systems on Mir were performing nominally.

Back on the balcony, I met Yuri Grigoriev, the deputy designer general of RKK Energia, a company born along with Soviet rocketry in 1946. RKK Energia's vast industrial park was located just a block away from TsUP. In 1965, as a young graduate of the Moscow Aviation Institute, Grigoriev joined what was then called OKB-1, a top-secret development center that was at the helm of the race with the United States to land a man on the moon. "It was the time of unconditional romanticism," Grigoriev remembered. Since then, he had managed the development of Russian spacecraft from Soyuz to Mir to Zvezda, a segment of the International Space Station. "Mir has been part of my life since the very beginning," he said as we walked into the crowded foyer outside the Mir control room, "and it is very sad to see it go before its time."

Grigoriev's main concerns extended beyond Mir. He worried about the future of his organization, hanging on a shoestring government budget. "Look, how can I hire young talent, when [Russian] private industry can pay college graduates several times of what I can offer?" he asked. "Good graduates still come to our company to get unique experience and skills, but they won't stay because it is impossible to survive on our salary.

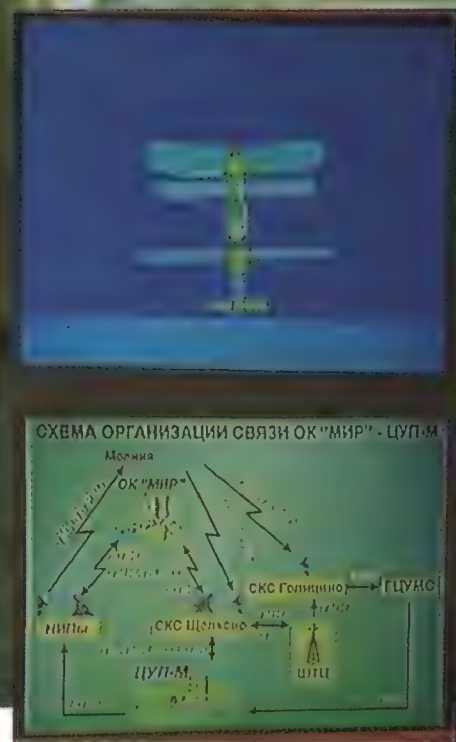
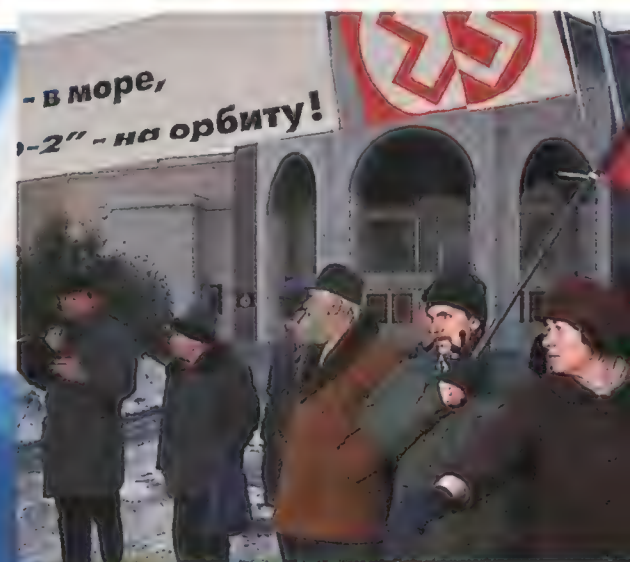
"As long as our government continues its present policies, I am pessimistic," he added. "It is abnormal for any country to sell out its national treasures—energy, resources, everything—to a few individuals." This is a belief that many in Russia share—that by giving control of Russia's resources to a few "oligarchs," the government lost its ability to finance the development of

The United States strongly supported the aging station's retirement; at TSuP, NASA engineers (lower left) watched the mission's end. For all the glitches that afflicted Mir over its lifetime, during deorbiting it behaved perfectly.

like Grigoriev feel for the old days.

Around eight in the morning, I re-entered the Mir control room via my secret route. I was just in time for the final maneuver, which would send Mir out of orbit and plunging toward the Pacific. Numerous TV reporters and cameramen lined up along the edge of the balcony.

As the flight commentator confirmed



various sectors, including technology.

As I mulled over Grigoriev's words, I noticed in the foyer an impressive bust of Vladimir Lenin towering over the nicotine-soaked twilight. Looking at it, I could imagine the man's ideas about social engineering and state-managed economy coming alive again, if only in the appreciation many Russians

normal ignition and burn in the third and final maneuver of the deorbiting process, Mir sent its last flickering video images to mission control: On the big screen, some distant shoreline veiled in splintered clouds floated by peacefully.

The top seats on the balcony were occupied by a crowd of diplomats, pri-

As the flight commentator confirmed normal ignition and burn in the final maneuver of the deorbiting, Mir sent its last flickering video images to mission control: some distant shoreline veiled in splintered clouds floating by peacefully.



SOVPHOTO/EASTPHOTO/TASS



PHOTOGRAPH BY NIKOLAI IGNATIEV

marily from the countries that were under Mir's reentry path. (Jaime Bautista, ambassador of the Philippines in Moscow, joked that a crash of Mir in Manila Bay would be a turning point in his career.) As they tried to understand the technical jargon and shaky English of the mission control commentators, they watched the map as it showed Mir's final swing over the

Eastern hemisphere. At 8:31 a.m., Mir left the range of ground control stations forever, and an official announcement confirmed that the station was on its way into the target impact area: a strip of the Pacific 40 degrees south of the Equator.

On the main screen, the map of the world was replaced with one you usually come across only in the back pages of atlases. Yet this morning, the region of the Pacific Ocean between New Zealand and South America became the most watched area on Earth.

I heard a commotion at the back of the balcony and turned around. One by one, captains of the Russian space industry were entering a guarded conference hall hidden behind the Mir control room. I later learned that in a strange reunion, Yuri Koptev, the director of the Russian Aviation and Space Agency, who had become an unwilling advocate of the unpopular decision to deorbit Mir, and Yuri Semenov, charismatic president of RKK Energia, who for years had defied the pressure to dump his beloved space station, had come together to drink a glass of vodka.

At 8:45 a.m., the mission control commentator reported that the U.S. radar station at the Kwajalein atoll detected Mir on its planned descent trajectory. Seconds before 9 a.m. the voice announced: "The station Mir concluded its triumphant flight." There were no cheers or applause, just a sigh of relief that swept throughout the control floor and the balcony.

The map disappeared from the big screen, and was replaced by a diagram of the Mir space station with a caption in Russian: "OK [Orbital Complex] Mir, Launch: 20.02.1986, Descent: 23.03.2001."

The bear-like figure of Yuri Koptev appeared from the conference room and was immediately aimed at by dozens of TV cameras and microphones. "This is a sad but inevitable event," Koptev

said stoically. "This spacecraft created the foundation for the International Space Station." Following his statement, Semenov and other officials emerged from their retreat.

Half an hour later, reporters and officials weary from the sleepless night gathered in a large conference center known as the blue room. Only there, after many hours in a windowless space, did I discover that the new day had started.

As the officials took seats around the conference table in the jammed room, Koptev joked: "Let our orphan Semenov take the central seat."

"This station could fly for another two or three years," said the RKK Energia president. "However, our goal was to end the mission in a civilized way."

Koptev again and again appealed to the press to understand the mission planners' predicament—that in Russia today, the money just can't keep pace with the ingenuity. "We are all very smart but very poor," he said. "We understand the emotions involved in this decision; however, we had to make this step."

Koptev's arguments failed to silence his critics. As I returned home from the long day at the TsUP, Moscow radio was reporting that Communist representatives in the Duma, citing the decision to deorbit Mir, had called for Koptev's resignation.

On a train leaving Moscow, I struck up a conversation about the deorbiting with the fellow sharing my car. It turned out he used to work at a research facility in the small eastern Russian town of Nizhniya Salda, where he had participated in the development and testing of engines for rockets and spacecraft, including Mir and Soyuz. "We are yet to learn how much we have lost," he said about Mir. "I see two possible outcomes: Either our space program will go down the crapper, or in a few years they will fathom what happened and make steps to rebuild the station."

When I quoted the price of operating Mir, he replied: "What is 250 million dollars a year for a country like Russia? Nothing. This is our Russian way: first to lose, rob, and destroy, and then to rebuild from scratch. The entire Russian history is like that." ➔



n the ramp at California's Edwards Air Force Base, the ancient B-52B, tail number 008, squats, its eight J57 Pratt & Whitney turbojets throbbing in their slim nacelles in preparation for its first flight of the millennium.

From the outside, NASA's oldest airplane looks tired. Primer peeks through patchy paint. A notch has been bitten out of the right flap. The billboard-size fuselage is stenciled with faded silhouettes of the hundreds of aircraft and other objects air-launched from its wing over the past four decades. But it's inside the cockpit that the airplane really shows its age.

Here, NASA research test pilots Gordon Fullerton and Frank Batteas confront dozens of antiquated analog gauges and clunky mechanical contrivances that date from the days when cars sported tailfins, computers ran on punch cards, and the only creature with any immediate prospect of going to the moon was Alice Kramden. "It's pretty awful from a human-factors standpoint," Fullerton, a former astronaut with two space shuttle missions in his log, says cheerfully. "Everything in here is somewhat obsolete. After a couple of hours of flying, you really feel like you've earned your pay."

This particular B-52, which answers to zero-zero-eight, double-oh-eight, and balls-eight, is the mother of all mothershops. Starting in 1960, it ferried the X-15 under its wing for air launches that would send the rocket plane into space. Later this year, it will do piggyback duty for the X-43/Pegasus, also known as Hyper-X, a NASA research craft designed to test scramjet engines originally envisioned for the X-15. During the intervening 41 years, 008 has played a critical role in 13 major programs. The wrinkled fuselage bears the icons of five lifting-body aircraft (M2-F2, M2-F3, HL-10, X-24A, and X-24B), horses (Pega-

NASA's antique bomber test flies a pylon adaptor for the Pegasus air-launched booster. A drone takes off (below) after getting a lift. The X-24A is launched from beneath the B-52's wing (opposite, bottom).

THE B-52 THAT LAUNCHED A THOUSAND SHIPS.

BY PRESTON LERNER

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sus, which powered the first air launch of a satellite), parafoils (the X-38 vehicle for returning space station crews), parachutes (F-111 crew escape module), and even an Alfalfa Impact Study (marking the crash site of a drone in an alfalfa field). There's also an icon connoting the Dumpster Impact Study, a spot on the aircraft that had to be patched after a wind gust blew an errant dumpster into the fuselage.

Nothing special is scheduled for this crisp January morning, just a few touch-and-gos to keep the pilots current and a quick test flight to check some recently completed repairs. On the ground, crew chief Dan Bain shuts the hatch to the fuselage. In the cockpit, the light indicating that the hatch is open continues to shine. Bain tries again. And again. "We've still got a light," Fullerton calls over the radio, no longer quite so cheerful. It seems preposterous that

a machine as sophisticated as a B-52—it cost \$8 million when it was built—could be grounded because a door won't close.

"Dan's going to get his wand," says electrical technician Gary Beard, who's inside the belly of the dark, surprisingly cramped beast, trying to help Bain lock the hatch. Magic wand notwithstanding, the locking bolts won't engage properly, and there's no thought of flying until the hatch is properly secured. "One time," Beard recalls with a laugh, "the slight increase in cabin pressure when we started up the air conditioning system blew the hatch off on the ramp."

My-kingdom-for-a-horse squawks are by no means unique to NASA, of course. But they're a special problem for 008, which, for the past quarter-century, has remained operational only by virtue of a resourceful brand of scav-

enging, jury-rigging, and ingenuity. This is the nation's last flyable B-52B. In fact, every other A, B, C, D, E, F, and G model B-52 has long since been dispatched to museums or boneyards. The Air Force still flies 94 H models, but these have virtually nothing in common with 008 other than the airframe.

"A lot of these parts just aren't made anymore," Bain says. He admits that he can't remember where this particular hatch came from—possibly from the D model displayed in the Edwards museum. "Take the autopilot. It's the last of its kind. Gary Beard was trained on it at Tinker Air Force Base in '93 by the last guy who'd worked on it, and that guy was already an old man about to retire, and he hadn't worked on it for 25 years."

Zero-zero-eight manages the neat trick of being just about the oldest airplane in the Air Force inventory as well

1 TESTING A DRAG CHUTE FOR THE SPACE SHUTTLE, 1990. 2 008 PREPARES TO LIFT OFF WITH THE M2-F2, 1965. THE LIFTING BODY PROGRAM PROVED THAT WINGLESS CRAFT COULD LAND LIKE AN AIRPLANE. 3 AN ESCAPE MODULE, WHICH SEPARATED THE COCKPIT FROM AN F-111, IS RELEASED FOR A TEST OF A NEW



PARACHUTE SYSTEM IN A PROGRAM THAT SPANNED TWO DECADES.



as the youngest—oldest because it's been flying since 1955, youngest because it had amassed only 2,384.5 hours during 1,014 flights through 2000. The Air Force tried to retire it in 1975, and NASA, which has had it on loan at the nearby Dryden Flight Research Center ever since, has been trying to replace it for at least a decade. A B-52G was evaluated in 1994 but rejected. An H model is supposed to arrive later this year, but it may not meet all of NASA's mission requirements. Meanwhile, 008 just keeps on going, and going, and going. "Every time we fly it, we continue to contribute to its history," says B-52 project manager Roy Bryant, who first became acquainted with the airplane when he was working on the X-15.

The mothership concept isn't unique to big, old bombers and Edwards Air Force Base. Parasite airplanes were fitted to larger aircraft and airships as

far back as the 1920s, and NASA uses two modified Boeing 747s to ferry space shuttles from coast to coast. (The Soviets carried their Buran shuttle on an Antonov An-225.) But the modern air launch concept was hatched for the Bell X-1's assault on the sound barrier in the late 1940s, and it was perfected on the desolate dry lakes of the Mojave Desert.

Because the rocket planes of the 1940s and '50s had such limited fuel capacity, they were carried aloft by B-29s and B-50s and dropped from the bomb bays (see *In the Museum*, p. 14). But the X-15 was significantly larger and heavier than earlier rocket planes. A more substantial mothership was required, and the obvious choice was Boeing's new B-52 Stratofortress. Designed to deliver nuclear weapons to every corner of the globe, the Buff—an acronym for Big Ugly Fat Fellow

(or something like that)—would have no problem lifting a 50,000-pound payload.

Double-oh-eight—that is, the eighth production Buff—was delivered to Edwards in 1955. Originally designated an RB-52B reconnaissance/bomber, the airplane was used to test bomb navigation systems until it was selected for the North American Aviation X-15 program. In 1958, it was sent to the North American plant in nearby Palmdale, where a pylon equipped with a heavy-duty hook assembly was mounted underneath the right wing, between the fuselage and inboard engines. The structural support for the pylon and the supporting systems forced the removal of one of four main fuel tanks, two of four ancillary tanks, and both external drop tanks. Also, a notch had to be cut in the right flap to accommodate the tail of the X-15.



HAVING DROPPED THE HL-10 LIFTING BODY AT 45,000 FEET, 008 SHOWS PILOT BILL DANA HOW AN AIRPLANE WITH WINGS PERFORMS. BEFORE TEST FLYING THE PAYLOAD, NASA TEST FLIES THE PAYLOAD PYLON ADAPTOR—HERE, FOR THE PEGASUS AIR-LAUNCHED BOOSTER.



The first X-15 air launch was performed by 008's sister mothership, an A model B-52 known as 003. Double-oh-eight got into the act on January 23, 1960, when Air Force Major Fitz Fulton flipped the switch that opened the hooks suspending the X-15 from the pylon of the B-52 and North American test pilot Scott Crossfield lit the eight chambers of his XLR-11 rocket engines while crooning "Back in the Saddle Again" over the radio. During the eight-year program, 003 and 008 performed 199 launches, typically at Mach 0.82 and 45,000 feet, with the X-15 maxing out at 53,100 pounds. Yet the Buffs got little of the glory and produced none of the drama associated with the high-profile, high-speed, high-altitude program. "Very rarely has a mission been aborted because of the B-52," says Bill Albrecht, a one-time X-15 engineer who continues to ride herd on 008 as Dry-

den's assistant director of operations. "When it's been called on, it's been there."

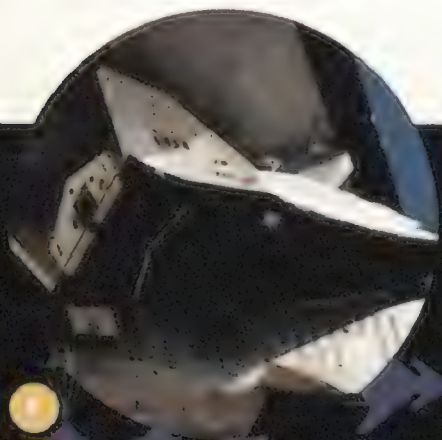
As befits a leviathan with a wingspan so broad—185 feet—that the wings are fitted with outriggers, 008 handles like an oceanliner. To compensate for the asymmetrical load produced by an object attached to the pylon, the fuel cells are filled—or partly filled, as the case may be—to balance the airplane, and the copilot adjusts the fuel flow from tank to tank during flight to keep the Buff properly trimmed. "When we dropped the X-15, the airplane would roll about 15 or 20 degrees, but it was easily controlled with the aileron," says Fulton, who first flew the XB-52 in 1953 and was still flying 008 when he retired from NASA in 1986. "It was just like dropping a big bomb."

The trickiest aspect of flying 008 stems from the fact that flaps, which

extend the wing area and allow controllable flight at slower speeds, aren't used because the inboard right flap had to be mutilated to accommodate the X-15. "An operational B-52 won't take off without flaps," Fullerton says. "And technically, a no-flaps landing is considered an emergency." While standard Buffs take off in a level attitude, 008's nose gear has to be yanked off the runway and the airplane takes off nose-up. Landings are hot—at least 35 mph faster than with full flaps—and the pilot can't do much to prevent the airplane from slamming down on the nose gear after the rear trucks hit the runway. "At times," Fullerton admits, "landings can be teeth-jarring."

After the final X-15 flight, in 1968, 003 was retired, eventually finding a home in the Pima County Air Museum in Tucson. But 008 continued to serve as the mothership for the lifting body

- 1 X-38, A SECOND-GENERATION LIFTING BODY, WAS DEVELOPED AS AN EMERGENCY RETURN VEHICLE FOR CREWS OF THE INTERNATIONAL SPACE STATION. 008 TOOK IT ON ITS FIRST FLIGHT IN AUGUST 1997.
- 2 ONE OF 008'S MOST GLAMOROUS HITCHHIKERS WAS THE X-15. ITS ROCKET ENGINES ALLOWED IT TO REACH 354,200 FEET AND 4,520 MPH (MACH 6.7).
- 3 SPACE SHUTTLE DRAG CHUTE TESTS MADE FOR HAPPY LANDINGS FOR BOTH THE B-52 AND THE ORBITER.



program. When the last of those wingless wonders flew in 1975, the Air Force planned to put 008 out to pasture. But NASA still had some use for the airplane, so in 1976 a loan agreement was negotiated, and 008 went back to work.

Since then, 008 has been the biggest component of myriad programs studying everything from high angles of attack to atmospheric conditions. Some, such as tests of the space shuttle drag chute, required only eight flights. Tests of the F-111 crew escape module, on the other hand, extended over parts of two decades. But it was a program to develop the parachute recovery system for the shuttle's solid rocket boosters that gave 008 the sportiest moment in its career. The hooks failed to open fully during a test flight, leaving a 50,000-pound dummy cylinder with a parachute on one end only partially attached to the pylon. When Fitz Fulton couldn't

shake it loose, he returned to Edwards—avoiding populated areas—and carefully set the airplane down, going easy on the brakes to avoid any damage from the loose payload.

Between 1990 and 1994, 008 launched the first six Pegasus rockets. (Since then, Orbital Sciences has used its own modified Lockheed L-1011.) In 1998, the B-52 returned to the X-plane business with the first drop test of the X-38, the vehicle to be used to return the space station crew in an emergency (it was recently put on the back burner). The X-43 Hyper-X program should take 008 well into the 21st century. Even if NASA gets its promised H model, that airplane would require millions of dollars' worth of structural modifications to carry the 42,000-pound Hyper-X.

Which brings us to the most delicious irony about 008: Obsolete or not, it's still uniquely suited for mothership

duty. Yes, its J57s are ridiculously inefficient, but the turbojets enables the airplane to fly higher than H models equipped with turbofans. Also, H models use spoilers rather than ailerons, and Fullerton fears they may not provide enough lateral control to counteract the roll produced when a heavy payload is dropped. Last but not least, though 008 is older than some of its pilots, the airframe is a spring chicken compared with H models that have flown as part of an operational squadron. "The biggest problem we have with the airplane," Albrecht says, "is that it's so hard to find replacement parts."

Considering that 744 B-52s came off the Boeing assembly line before production ceased in 1962, there ought to be no shortage of components. And in fact, 008 has been retrofitted with hundreds of bits and pieces salvaged from Buffs in museums—a practice now



THE X-38 FROM 008'S OBSERVATION WINDOW. 008 CELEBRATES THE 40TH ANNIVERSARY OF ITS FIRST FLIGHT WITH ONE OF NASA'S F/A-18 CHASE PLANES IN ATTENDANCE, JUNE 1995. MILT THOMPSON BOARDS THE M2-F2, 1966.



prohibited by Air Force edict—and boneyards, most notably Davis-Monthan Air Force Base in Arizona. Moreover, the crew has amassed a sizable inventory of spares.

Then again, many parts arrive at Dryden marked “Condition Unknown,” and the only way to test them is to install them and hope for the best. Other components, meanwhile, are simply irreplaceable. A few years back, for example, the airplane was out of commission for 11 months while a leaking fuel cell was repaired. But the biggest headache is what Fullerton calls “the infamous bleed air system.”

Many jets use high-pressure bleed air from the engines to run the air conditioning. But 008, like all early B-52s, is packed with hundreds of feet of ducting through which bleed air drives not only four alternators but also 10 hydraulic packs that power the landing gear, spoilers, trim tabs, and vertical

stabilizer. (Thanks to the clever aerodynamic design of the control surfaces, the cables that manipulate the ailerons, rudder, and elevator don’t require any hydraulic boost.) Besides being extinct, these hydro packs are notoriously temperamental, so the maintenance crew has had to develop its own test rig.

With all of the modifications made over the years, 008 might be best described as a B-52B-plus. The fuel gauges are from a C model, the ejection seats from a D, the drag chute, landing gear, and brakes from a G. The height of technological wizardry in the cockpit is an off-the-shelf GPS unit you might find in a Cessna. Oh, and there’s a homey digital timer originally designed to keep track of turkeys and pot roasts. “Well, at least we’ve got a VHF radio,” Batteas jokes. “Sometimes,” says Ken Wilson, a member of the ground crew, “I feel like a museum curator.”

The fact that 008 continues to thrive is a tribute to a cadre of workers who have made the airplane their life’s work. Beard, for instance, has been assigned to it since he graduated from high school 20 years ago. Bain, meanwhile, is only the fourth crew chief since the mid-1960s. He can’t help but regard 008 as more than the sum of its fragile and obsolete parts. “I’ve got the best job in the world,” he insists.

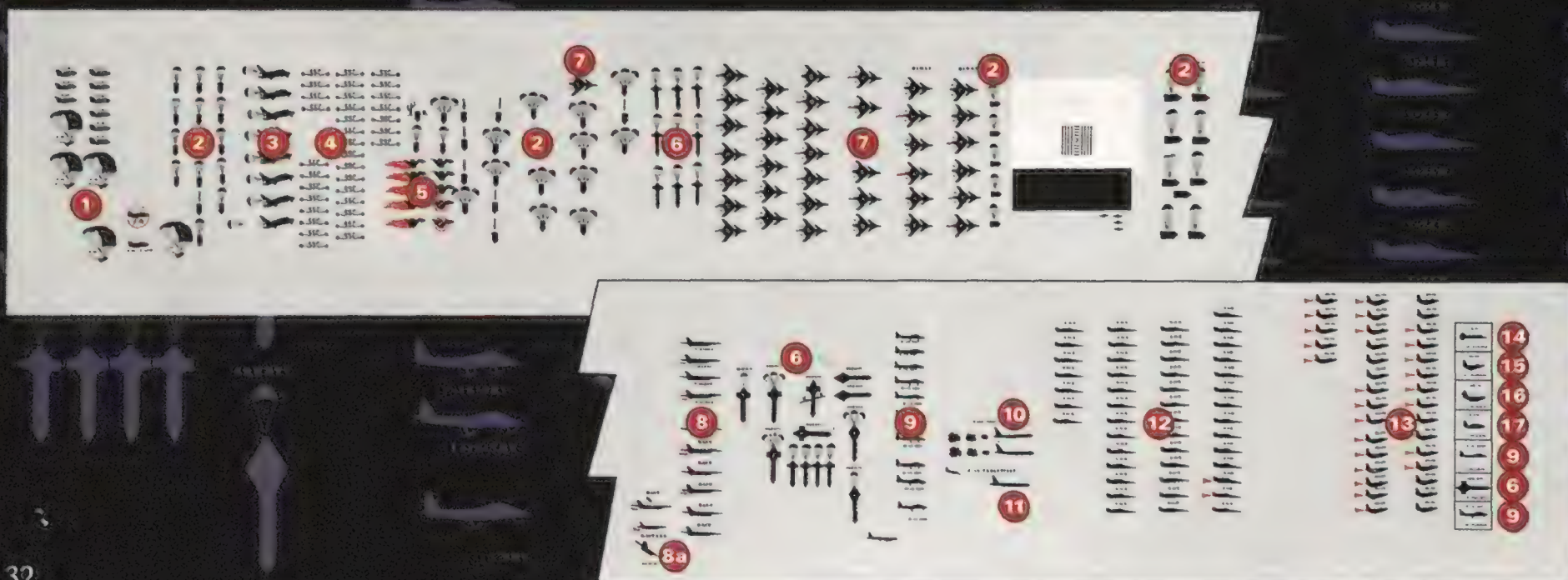
Wearing a bandana, the tattooed Bain gazes fondly at 008 while he smokes a cigarette outside the trailer the maintenance crew uses as its office. “I love this plane,” he says. “It’s like a classic car. There’s no reason it can’t fly for another 10 or 15 years. They tried a G model but we got rid of it. Now they’re talking about an H, but we can carry more and we can go higher. Besides,” he adds with a wicked grin, “we don’t want a new car. The old one’s already paid for.” —

Mission Markings

- | | |
|--|--|
| 1 X-38 space station crew return vehicle | 8a DAST Alfa Impact Study |
| 2 F-111 escape capsule parachute tests | 9 3/8-scale F-15 spin research vehicle |
| 3 Space shuttle drag chute | 10 Wake vortex studies |
| 4 Supersonic cruise emissions environmental studies | 11 F-16 radar target test |
| 5 Pegasus air-launched booster | 12 X-24B lifting body |
| 6 Space shuttle solid rocket booster casing recovery parachute | 13 M2-F3 lifting body |
| 7 HiMAT (highly maneuverable aircraft technology) | 14 X-15 rocket research aircraft |
| 8 DAST (drones aerodynamic structures test) | 15 M2-F2 lifting body |
| | 16 HL-10 lifting body |
| | 17 X-24A lifting body |



F-111 escape capsule parachute





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Investigators-in-training begin unraveling the mystery of a Piper Malibu that crashed in flames into a pier. A model will help witnesses describe what they saw (opposite).

READING TH



AIR CRASH INVESTIGATORS TRAIN STUDENTS TO FIT LITTLE PIECES INTO THE BIG PICTURE.

An image of a wrecked U.S. Air Force C-119 transport flashes onto the screen.

"What do you see here?" instructor Ray Wall asks.

The students, sitting in a classroom cluttered with a variety of twisted and broken airplane parts, study the image. A few hands hesitantly go up.

"It looks like he overran the runway," one student says.

"No," Wall retorts, clearly ready for just that sort of response. "Describe factually what you are seeing, and leave your opinions at home. Your job is to gather the facts—the National Transportation Safety Board members make the interpretations."

The rest of the hands go down. Wall helps them out: "The right side of the forward fuselage has compression buckling. The props are not feathered. There is substantial deformation with crushing. And see these people walking around? Have they touched anything? You now have a contaminated investigative area." For this group of 33 aspiring air crash investigators, school has begun.



THE WRECKAGE

In a classroom tucked into the third floor of a boxy 1960s government building on the campus of the Federal Aviation Administration's Mike Monroney Aeronautical Center in Ok-

lahoma City, they are here to learn how to sort out the aftermath of aviation's dark side. The class is offered to FAA investigators, airline and military aviation specialists, even new members of the NTSB—anyone who will be on a crash scene gathering evidence to turn over for the official NTSB review. During this six-and-a-half-day intro-

BY ERIC ADAMS PHOTOGRAPHS BY SCOTT SUCHMAN

ductory course, which is conducted by the Transportation Safety Institute's (TSI) Aviation Safety Division, the students will absorb lectures, view slides and videos, read radio transcripts, pass around failed engine parts and broken struts, and examine many cautionary case studies. Then, after five days of classroom work, they'll break into teams and venture into the "boneyard," a fenced compound containing the transported remains of a half-dozen real crashes that the students will investigate.

First, though, they have to learn the vocabulary. That's what Wall, a retired NTSB accident investigator with more than a thousand investigations under his belt, is helping them do. When another image hits the screen a short while later—this time a single-engine Cessna—Wall asks the same question and gets a faster, better reply.

"The nose gear is collapsed, and both prop blades are bent," the student says.

"Good. And what does that tell you?" Wall asks.

"The prop was rotating at impact."

"Right."

An hour later, the class has it down:



1 "Broom strawing" in fire-damaged aluminum is a sign that the fire originated in flight.

They can spot bowed flanges, shorn bolts, torsion, and ground scars immediately. Learning how to accumulate such details and objectively assess their significance, Wall tells them, is the first step toward narrowing the possibilities for the cause of the accident. The real answers, after all, are often very far from what first impressions may suggest and usually include multiple failures, so investigators must have a comprehensive understanding of what the aircraft—and, ultimately, its crew—has gone

through. Wall describes some of the analytical tools available. He tells them to document the site with videos, photographs, and grid sketches showing debris distribution lines. Another trick is vector analysis, drawing arrows on the wreckage that show the direction that forces are being applied. "You'll get the big picture very fast," Wall says.

Emphasis on the big picture is clear in the range of the course curriculum. It's a general introduction, and it's just one of many that investigators will take throughout their careers. The class, which is taught by TSI, NTSB, and FAA staff as well as aviation industry experts, covers all types of aircraft and gives equal weight to both clinical discussions of aircraft component failure modes and the human side, describing how to work with witnesses, survivors, and family members and what investigators might experience at the site. "When you arrive at a bad accident site, I guarantee you you will not sleep that night," warns Frank Del Gandio, an FAA investigator who lectures on crash-scene biohazards, including blood-borne pathogens such as the hepatitis virus and HIV. "In

An undamaged propeller blade tells the team studying this Helio Courier that its engine wasn't running at impact.



fact, you might find you're not sleeping for days. That's normal. Don't worry. But you need to focus on that investigation. Focus on the people you might be able to help in the future."

That's a virtual mantra for accident investigators, who must often work at remote and inhospitable sites and with a mind-numbing collection of variables. Their cause, though, is safety—to figure out precisely what happened at each accident so that the problem can be prevented from happening again. According to the NTSB, there are roughly 2,000 aviation accidents per year, most involving small general aviation aircraft and about 700 involving fatalities. All are thoroughly investigated with a variety of team configurations that can include representatives from the airline, if applicable, the aircraft manufacturer, and any part suppliers or airport personnel who might contribute useful records or data. If there are fatalities, the NTSB will lead the on-site investigation. If not, the board might delegate the investigation to the local FAA office. (The FAA, which is responsible for regulating the aviation industry and operations, always participates in investigations in support of the NTSB.) In all cases, the facts are reported to the five-member board, which will review the accident, develop a probable cause, and possibly issue recommendations for the FAA to enact.

The Transportation Safety Institute, a Department of Transportation division charged with training investigators of aviation, highway, and marine accidents, trains some 600 FAA investigators a year. It also opens its doors to tuition-paying military and commercial airline safety specialists. In the course I'm participating in, most of my classmates are these specialists, who oversee flight operations with an eye toward

safety procedures, training, and maintenance and who might eventually participate in investigations that their companies or military units conduct in support of or in addition to an NTSB inquiry.

All training stresses that accident investigation is a team effort. After a crash is reported, the investigators, led by the Investigator In Charge, break into groups, each of which gathers evidence about the pilot, the powerplant, the aircraft structure, air traffic control, the weather, and other factors. They interview witnesses and begin sorting through debris. The students are taught that they must account for every component of an aircraft, if for no other reason than to rule it out as a contributing factor.

One of the biggest challenges in that respect is determining whether components were damaged before the accident or during it. Among the most thoroughly addressed subjects is fire. Wall passes around a small charred canister. It's an oxygen container identical to the one that started the fire that brought down ValuJet Flight 592 in the Florida Everglades in May 1996, killing 110 people. This one was used to test whether such a fire could have occurred, and its presence silences the room. "Always suspect the possibility of in-flight fire," Wall says. "When a fire is in the slipstream and fueled by lots of oxygen, such as in an engine, temperatures can exceed 3,000 degrees, whereas on the ground they will usually stay below 2,000 degrees."

Materials leave distinctive signatures when subjected to certain temperatures, he continues, thus possibly revealing whether the fire occurred in the air or after the crash and where it originated. Rubber hoses, for example, will melt at 400 degrees, aluminum alloys at 1,000 degrees, and stainless steel at 3,100 degrees. Furthermore, when aluminum melts on the ground, it will puddle due to gravity, but when it comes apart in an in-flight fire, it produces the "broom-straw effect," in which the points where the metal has come apart will look stringy.

Other damage might require closer inspection. Andy McMinn, a TSI staff instructor, briefs us on metallurgy and how to use it to determine what caused a part to fail. Throughout his talk, he refers to crystal structure—how atoms are arranged—and discusses the various ways parts can change, depending on whether they have been subjected to fatigue, violence, or some other stress. Parts usually fail by overload, the material can be ductile or brittle, and the failure will leave important clues. "Fatigue manifests itself in 'beach marks,' like tide marks in the sand," McMinn says. "If a rectangular plate is pulled and compressed thousands of times, beach marks will indicate the direction of crack propagation. When the cracks reach a critical size, you'll see progressive failure and then instantaneous failure."

The course's aggressive pace is relieved by breaks and lunches—but even then there's something to see. Instruc-

Richard McCoy and John Friday find more damage in a Piper Aztec's remains (below). The course prepares students for everything they would encounter at a crash site—including journalists, role-played by Rick and Gwin Lippert (left).





The team investigating the Malibu looks for discoloration on the firewall, associated with in-flight fire temperatures above 2,500 degrees. Instructor Andy McMinn discusses how structures react under aerodynamic stress (above).

tors show videos of airplanes crashing and documentaries about the accident investigation process. The classroom itself contains exhibits on investigation processes and equipment, examples of component failure, an enormous cut-away of a Teledyne piston engine, and framed, illustrated case studies showing the effects of inexperience, bad luck, aircraft neglect, and poor judgment. One shows an old Cessna sitting crushed, nose down, on the side of a mountain. The pilot, who had been killed, had only a student license that had expired five years before, and a list found in the cockpit showed about 30 repair items that needed attention, but there was no evidence that any of the repairs had been completed. The airplane had had its last annual inspection five years before the crash.

Mike Grimes, a Teledyne engineer who lectures on engines and propellers, knows that in accidents such as that any number of factors could have contributed. So he tells us to start at the front of the airplane and decide whether the engine was running when the airplane crashed—and then determine what might have caused the engine to stop. “Look for propeller damage that requires a lot of energy,” he says. “Are there massive chunks of aluminum torn out of the leading edge of the blade? Is the hub broken?”

But what if a propeller is missing? Why did it drop off?

“How do you find a missing propeller?” he asks. “You can’t use [FAA tracking] radar data because the propeller is too small, but you can use it to see where the airplane started coming down. That’ll give you a general idea. Then the in-

surance adjuster becomes your best friend. Why? He’s got the checkbook. Get him to place an ad and offer a reward. Everyone with an SUV is going to be out looking for that prop.”

The other side of crash investigation is, of course, the people—the investigators, the victims, and the survivors. The more harrowing aspects of crash investigation have to be addressed with care and sensitivity. Though the course stays away from graphic images in the classroom, there is a file of photographs that help prepare students for what they might see, and they can view them whenever they choose. “You never know how you’re going to respond,” McMinn says. “We’ve had students look at the pictures and say, ‘I’m in the wrong business.’”

One student, Ernest Menet, a technical operations safety manager at Delta Air Lines in Atlanta, is asked to talk to the class about his own experience at a crash site. He was one of the first on the scene when Delta Air Lines Flight 191 crashed at Dallas-Fort Worth International Airport in 1985, killing 134. The accident was attributed to wind shear. “I was really not prepared for what happened that day at DFW,” he begins. “We got a report of an aircraft down, and they thought it was one of ours. We drove out, but it was raining so hard we couldn’t see anything. So we just started walking around, and I began to see the wreckage. I saw some people strapped to their seats who looked just fine, but were dead. I also saw dismemberment, horrible burns, children. That struck home because I have two daughters.

“I felt responsible for what I saw,” continues Menet, who is taking the course to buttress Delta’s accident preparedness. “I looked at the wreckage and thought that these people trusted their lives in what I do. As the head of main-



2 *The window and cabin damage suggests that when the Malibu hit the ground, a fuel cell ruptured, causing a low-grade fire. But a loose fuel line started the fire in flight, and that was what caused the accident. Mike Grimes provides clues to the cause of propeller failure (right).*

tenance, I coordinated our participation in the investigation. I ran on adrenaline for the entire week. I got three hours of sleep each night. When it was over, it was almost a letdown. I started withdrawing into myself, I stopped talking to my family. I had to go through counseling. For those of you who haven't seen it, I hope you don't. But it changes you for the rest of your life."

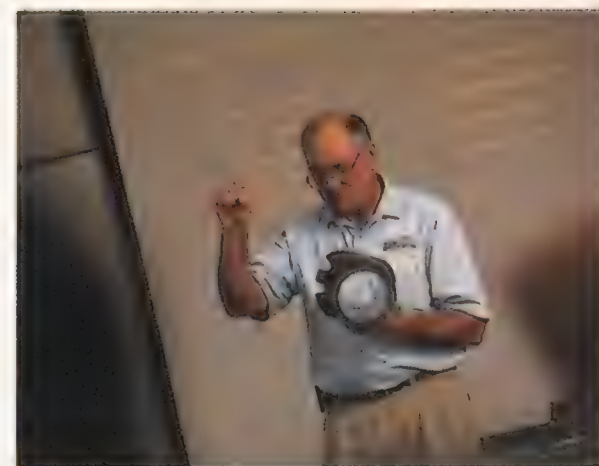
In the boneyard, we finally get to apply what we've learned. The team to which I am assigned confronts a mysterious accident involving a twin-engine Piper Aztec. The airplane crashed inverted in a pasture in Oklahoma after an engine and a large part of the wing fell off. Inside the wreckage, police found \$35,000 and several dozen spotlights and motorcycle batteries.

While one team begins sifting through the wreckage, Keith Cianfrani, as Investigator in Charge, and I, as public relations chief, set about securing the site and talking to witnesses, local police, and gawkers. As they do at all of the crash sites in the courtyard, the TSI staff, playing these characters, do their best to challenge the investigators. A friend of one witness reveals that the witness took parts of the wreckage as souvenirs. McMinn comes over as an off-duty air-traffic controller who saw the pilot working on the left engine the previous day. The local sheriff asks if she can keep the \$35,000 found in the airplane so her department can buy a new squad car.

Then a television journalist and her cameraman—veteran Oklahoma City journalists Rick and Gwin Lippert—arrive and promptly begin aggressive cov-

erage. They aim the camera over our shoulders to videotape our notes and use microphones to eavesdrop on conversations among investigators—both of which can lead to premature assessments or incorrect information being broadcast to the public. On air, Gwin gives me information I didn't know: The airplane was flying along a known drug route. She also points out that the registration number on the fuselage is merely duct tape. "Don't you find that fishy?" she demands. "Yes, that is fishy," is the only reply I can manage.

Other team members are making substantial progress. They've noticed some broom strawing near the left engine, and conclude that an in-flight fire had torn the wing and engine from the fuselage, in spite of the pilot's efforts to shut off fuel to the engine, as evidenced by switch positions in the smashed cockpit. Later in the classroom, we get the whole story: The pilot was flying to a rendezvous with other aircraft, transporting drugs from Mexico. The spotlights in the baggage compartment were to be used as runway lights at the secret airfield. While working on the engine the day



before, the pilot didn't tighten the fuel lines sufficiently, and leaking fuel ignited on the hot engine.

Accidents such as this are particularly frustrating for crash investigators and safety experts, more because the pilot was careless than because he was participating in illegal activity. "The bottom line is that the majority of these things are preventable through personal training or discipline," Wall says. "So it's frustrating when people make poor decisions, like taking off into icing conditions or not properly maintaining their airplanes."

The students are no strangers to aviation, but they still come away impressed by the investigation process. "It was amazing to see the story unfold in the smallest of details," says Friday, who monitors Boeing 757 maintenance for American Trans Air. Jack Combs, an Army Reserve helicopter pilot and safety officer at Fort Lewis, Washington, says he learned patience. "The TSI taught us to not form a quick opinion," he says. "Just sit back, look, listen, and then carefully investigate." ➔



3 *The crushing of the aluminum around the landing gear of this Cessna 152 helps students find the angle of impact—45 degrees.*

Resto

Homecoming | Handley Page Halifax



NORWEGIAN ARMED FORCES MUSEUM

ROBERT RUDHALL

Like many British and Canadian bomber pilots during World War II, Jeff Jeffery flew most of his missions at night to avoid German fighters. He took the four-engine Handley Page Halifax Mk.7 across the English Channel 32 times between July and Christmas Eve, 1944, to bomb German industrial cities along the Rhine. He remembers seeing enormous blue search lights roving the sky to find the bomber fleets for German anti-aircraft gunners. "You had about 10 seconds to get out of that light," Jeffery remembers. "I saw six aircraft go down one night."

More than 50 years later, Jeffery participated in another night operation—actually an all-day, all-night, weeks-long exercise to salvage from a Norwegian lake the aircraft he loved to fly. In 1994, Jeffery, who had been awarded the Distinguished Flying Cross, and fellow Canadian and Air Canada

captain Karl Kjarsgaard formed the Halifax Aircraft Association to recover and eventually restore a Halifax Mk.A7 bomber that local enthusiasts using rented sonar equipment had found at the bottom of Lake Mjøsa, near Lillehammer, in 750 feet of water. The two decided to bring the bomber home to Canada. Of more than 75,000 Halifax missions flown during World War II, 29,000 were flown by Canadians. More than 10,000 crewmen were killed.

The aircraft that the Halifax Aircraft Association is now restoring is serial number NA 337, which left England for Norway on April 23, 1945. The crew found the drop zone and jettisoned the load of supplies for Norwegian resistance fighters without incident, but, turning for home, the Halifax overflew a heavily defended bridge at the southern end of Lake Mjøsa. Flak struck the right wing, starting a fire that took out both starboard engines. A night ditch-



NASM

Canadian crews flew 29,000 missions with Handley Page Halifaxes in World War II (above).

ing in the frigid lake was the crew's only option.

The big bomber hit the waves hard, the rear third of the fuselage broke off, and the rear gunner, Flight Sergeant Thomas Weightman, was knocked unconscious. Revived by the icy waters, he managed to get a raft out of the aircraft before it sank. He was the only crewman of six to survive.

When Jeffery and Kjarsgaard went to Norwegian salvage firm Dacon In-

ration



NORWEGIAN ARMED FORCES MUSEUM



Left: Two of the Halifax's Bristol Hercules radials after recovery. Today, the engines are spotless again thanks to John Wells and Ivan Matthews (below).



ROBERT RUDHALL



#8 WING TRENTON

Opposite, left: The center section of a Halifax undergoing restoration at the Royal Canadian Air Forces Museum in Ontario. Center: The rare Halifax as it emerged from

Norway's Lake Mjøsa. In 1996, the sections were laid out (above), revealing that 12 feet of fuselage was missing. Below: Keith Jennings rebuilds a wing spar.

dustry Inspeksjon in 1995, they were told the operation would cost \$320,000. They had only \$250,000 from the Canadian government. But because of the wrecked Halifax's mission, the firm agreed to go ahead with the work before the remaining funds were raised. And because Canada had trained many Norwegian aircrews during the war, the Norwegian government donated the Halifax to Canada as a sign of gratitude.

The tail and rear fuselage of the 50,000-pound bomber broke the lake's surface on August 15, 1995. On September 10, the rest was hoisted free. Thomas Weightman was there to see it.

Several weeks later, the disassembled aircraft was flown by C-130 to the Royal Canadian Air Forces Museum in Trenton, Ontario, where it is being restored. The result will be the only complete Halifax of three in the world. Donations to the Halifax Association remain strong, so the volunteers have plenty of tools and supplies. However, the Halifax is missing one key piece. Thomas Weightman has his thermos bottle back, which was recovered from the tail turret after it had lain at the bottom of Lake Mjøsa for 50 years. Not surprisingly, the coffee was cold.

—J. Douglas Hinton



ROBERT RUDHALL

CO

LIGHT

IN

TO

THE

PHOTOGRAPHS BY CHERYL ROSSUM

SPACE





Although McDonnell Douglas was the prime contractor for F/A-18s, the aircraft was derived from the YF-17, built by Northrop. "As this was a \$40 million prototype and the only one of its kind, one of our major concerns was not dropping anything onto it from the cherry picker [65 feet above the aircraft]," Rossum says. While securing equipment, she hit her head and was taken to a nearby hospital, where she grew concerned that the sun would move and no longer create the shadows she had planned. Clearly, she made it back in time.

here are photographers who express in their work aviation's speed and power; others have a knack for revealing the personalities of individual airplanes. Cheryl Rossum, whose 1967 degree from Barnard College is in art history and literature, has something different to say.

The photographs in this collection were commissioned by the Northrop Corporation for its 1978 and 1982 annual reports and by the Loral Corporation in 1993. Although the expression "museum quality" is used often in connection with Rossum's photographs, her pictures have never been exhibited in a gallery or museum. This we consider a classic case of, if you'll excuse us, underexposure.

"There is a taint in a sense by being a 'commercial' photographer," Rossum says of her relationship with the art world. As a commercial photographer, "you need to be either old or dead to be considered artistic."

Alisa Zamir, design director and executive vice president of the graphic design firm Taylor & Ives, had worked with Rossum on projects for the New York Stock Exchange before hiring her for the Loral Corporation's annual report. "We already had enough photographs of people in a lab wearing bunny suits," Zamir says of the routine portrayal of aerospace technicians in clean rooms. She knew she'd get something "intelligent" from Rossum, who hadn't so much as held a camera before her first full-time job—as a photographer's assistant—but had achieved a small degree of fame in 1975 for a stunning treatment of industrial subjects she photographed for the annual report of Combustion Engineering.

Even if you've spent a lifetime studying airplanes or working with aerospace components, we doubt you've seen them in quite the way Cheryl Rossum shows them to you.

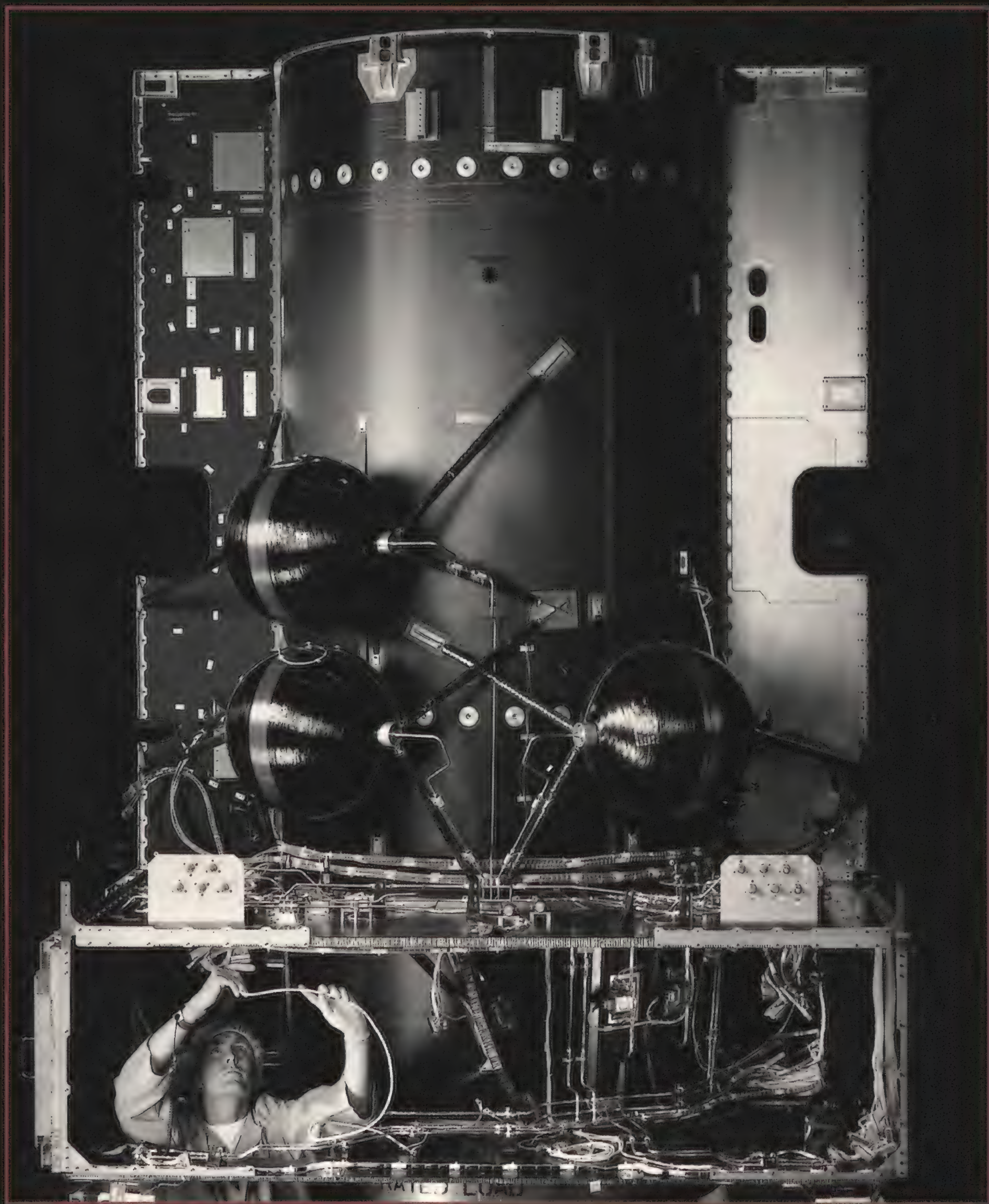
—The editors



Her subjects at Loral, Rossum says, were more mysterious than the aircraft at Northrop and had an almost magical quality. In this photograph, a prototype sensor chip for a U.S. Army light attack helicopter's navigation and targeting system emerges from the sub-frigid environment of a test chamber. Loral technicians, outside the frame of the photograph, assisted in its creation by blowing on the chip.

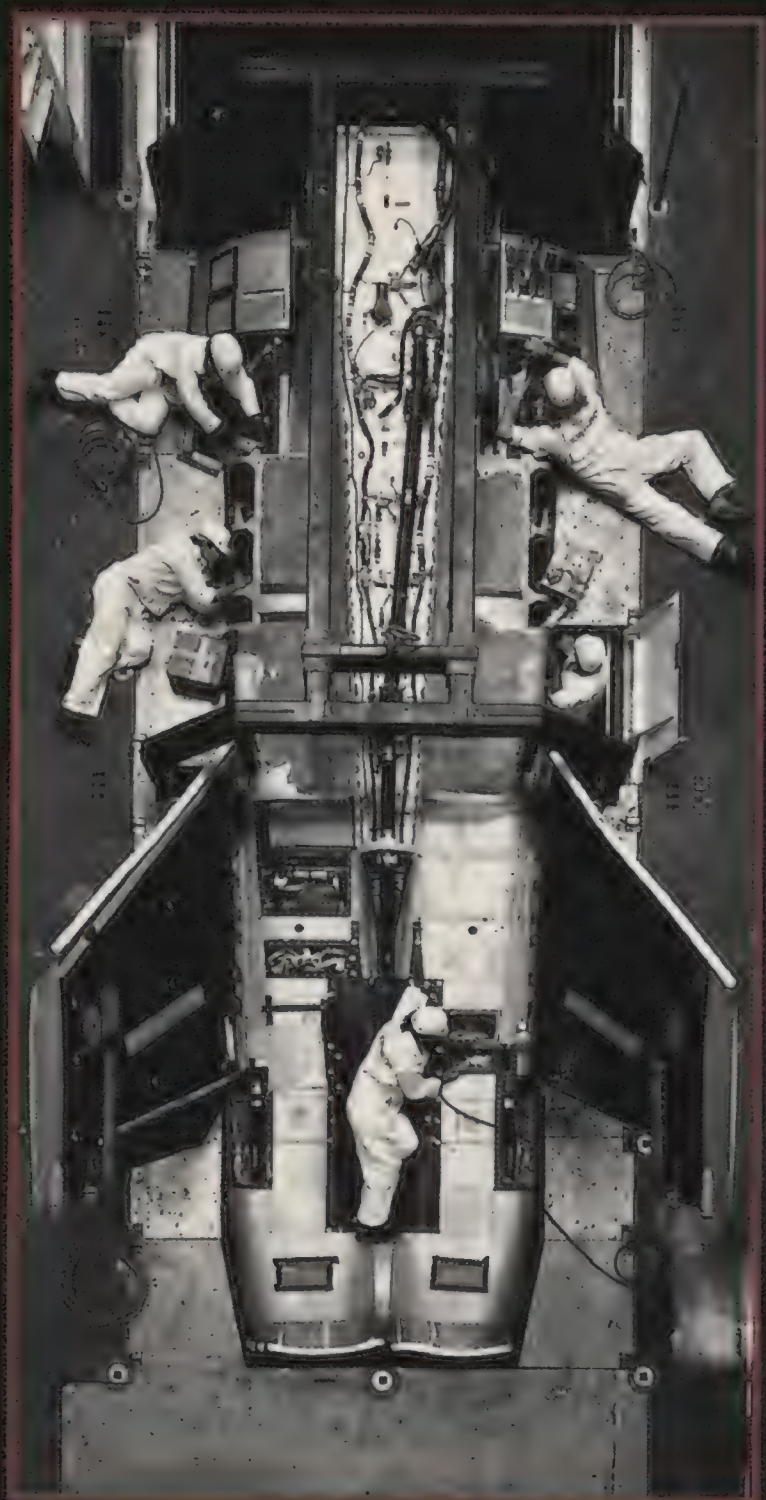
Of more than 1,500 subcontractors working on Boeing's 747 in 1978, Northrop had the biggest job: manufacturing the 20-ton, 153-foot-long fuselage at its Hawthorne, California plant. The 27 panels and nine doors for each fuselage were then shipped in custom-made railroad boxcars to Everett, Washington. Rossum, who has described her work as "balletic," says she choreographed this shot.





A skinless Space Systems/Loral Intelsat VII-A satellite affords Rossum the opportunity to explore a favorite theme: the integration of man and machine. She was inspired by a Russian novel, written around 1917, "about space exploration and the building of a spaceship and how individuality gets lost to the state," she says. When she places people in relationships with machines, she sees both a beauty and a danger in it.

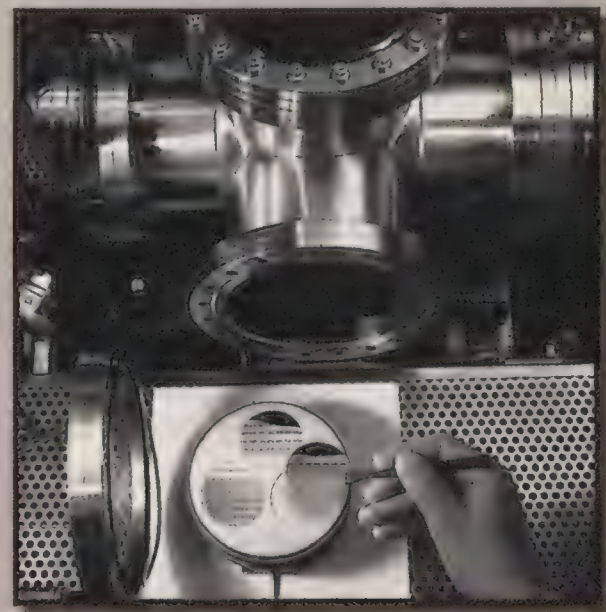
A sense of the intrinsic goodness of the manufacturing process has been with Rossum, she thinks, since the day her third-grade class took a field trip to a Bond bread factory. "I remember walking into this really dusty place, and I could hear this clanking," she says. The children walked through the noise and machinery, "and at the end of it," says Rossum, "this door opened and out came these warm, beautiful-smelling loaves of bread. And to me it was such a miracle that I remember it to this day." At the Northrop factory in Los Angeles in 1982, Rossum photographed the assembly line for the center and rear fuselage and twin vertical tails of the F/A-18 from a series of catwalks close to the factory ceiling. These are two shots from a series of eight. The full series shows the aircraft take on more and more of its systems on its way to completion.





The Northrop quality assurance examiner in this photograph is checking for flaws in the highly polished skin of 747 fuselage sections. The subject of the photograph, though, seems to be the patterns formed by window openings and lines on the shop floor, shadows of the hanging sections, and the confusion between real objects and their reflections.

Circles in circles in circles: Rossum's photograph at the Loral laboratory in Newport Beach, California, contrasts the heavy structure of a test chamber with the delicate wafer of mercury cadmium telluride. The wafers are used to make infrared focal plane arrays for advanced reconnaissance systems. In what designer Alisa Zamir called "a junkyard of square pieces," Rossum found an abstract order.



FAD E T

Dickens might have called it *A Tale of Two Terminals*. For Karolen Paularena, it is the best of times. The morning brings a new batch of ones and zeros, beamed to Earth from the depths of space and zapped overnight to her Sun workstation. Paularena and her colleagues at MIT's Space Plasma Laboratory in Cambridge, Massachusetts, are studying the solar wind, the sun's supersonic exhalation of protons, electrons, and magnetic energy, and key to that effort are the speed, direction, and intensity measurements they get from a NASA probe that almost no one has ever heard of: the Interplanetary Monitoring Platform 8.

For Lawrence Lasher, a continent away at NASA's Ames Research Center in Mountain View, California, things are not so rosy. It may not be the worst of times, but he's had little to cheer about lately. Lasher serves as project scientist for the only two active spacecraft under Ames' control: Pioneer 6, which NASA no longer listens to even though it is still functioning, and Pioneer 10, which has been heard from only once since last August. Although outwardly optimistic, Lasher is hedging his predictions about when—or whether—the control-room computers waiting to communicate with the spacecraft will be used again.

The Ames and MIT teams share the distinction of working with craft that left Earth improbably long ago: IMP 8 in 1973, Pioneer 10 in 1972, and Pioneer 6—incredibly—in 1965. "We've got graduate students coming in to work with a spacecraft launched be-

BLACK

BY J. Kelly Beatty

ILLUSTRATIONS BY

Paul DiMare

NOW AND THEN,

THE FAINTEST

WHISPER

RETURNS FROM

NASA'S DISTANT

SPACE PROBES.

fore they were born," Paularena observes. Given NASA's recent run of bad luck in getting to relatively nearby Mars, the endurance of these Space Age elders seems all the more remarkable.

The engineers who designed and built them aren't really surprised. B.J. O'Brien joined the Pioneer development team at Space Technology Laboratories (later incorporated into TRW) in 1964 and took over as project manager in 1967. "As the program name

age. Instead of asking banks of thrusters to maintain rock-steady orientation in space, the Ames-STL team stabilized their craft by spinning them. Finally, these birds had no brains—they transmitted their data continuously and executed changes only when commanded to by ground controllers.

It was a bullet-proof design philosophy that paid off handsomely. When Pioneer 6 headed off into solar orbit 36 years ago, project scientists hoped

craft's 35th anniversary. Lasher thinks it can continue indefinitely. And for all anyone knows, its sibling Pioneers, 7 and 8, remain in good shape too; when last contacted in the mid-1990s, they were still phoning home.

Emboldened by the project's initial success, in 1967 the agency approved a plan dreamed up by renowned space physicist James Van Allen and other members of the agency's Lunar and Planetary Missions Board. A pair of Pioneers, each bristling with 11 experiments, would trek to Jupiter and dash through its surrounding radiation belts.

Puttering around in solar orbit was one thing, but plunging headlong through lethal doses of high-speed electrons was another altogether. The design by O'Brien's team used radiation-hardened electronics and shielded critical components wherever possible. "They were pretty rugged spacecraft," says Van Allen. And because weak sunlight at Jupiter's distance would have required enormous solar cells, these long-haul craft carried their own juice: plutonium-fueled powerplants called radioisotope thermoelectric generators, or RTGs.

Pioneer 10 rocketed away on March 2, 1972, and reached Jupiter 21 months later after threading the uncharted asteroid belt without incident. The target point was just 81,000 miles from the giant planet's colorful cloud tops, and as Jupiter loomed larger several of the radiation detectors topped out. "The counts just kept going up up up," Van Allen recalls. Back in California, anxiety peaked as the craft slipped behind the planet and out of radio contact. "Those were 15 of the longest minutes in my life," says O'Brien. Telemetry later showed that a few transistors had failed and exposed optics had darkened, but there were no serious malfunctions. The triumphant flyby earned the project team an Emmy (for its real-time broadcast of Jovian cloudscapes) and O'Brien a bottle of gin (a side bet with one of the scientists).

Pioneer 11 proved up to the task as well, sweeping past Jupiter in 1974 and Saturn in 1979. No one really knew what kind of environment lay beyond Jupiter, but the Pioneers might find out. Nor could anyone predict exactly how long the spacecraft would last, though in



Pioneer 11 greets Saturn.

implied, we knew we'd be breaking new ground," O'Brien recalls. "To us, reliability meant simplicity." All critical subsystems, such as the radio transmitter and power supplies, utilized designs that had already flown in space, and each had a backup. Because very-large-scale integrated circuits hadn't yet appeared, the Pioneers used smaller boards (and, for the early models, discrete transistors) that were more tolerant of faults and radiation dam-

to glean six months of readings from its magnetometer, plasma sensors, and cosmic ray detectors. If the craft lasted that long, the STL team would earn a sizable performance bonus. "Obviously," O'Brien wryly observes, "we didn't have to worry." NASA stopped tracking Pioneer 6 in 1997, though last December 16 a receiving station in the Mojave Desert locked onto its radio beacon—a carrier "tone" that included no data—for two hours to mark the

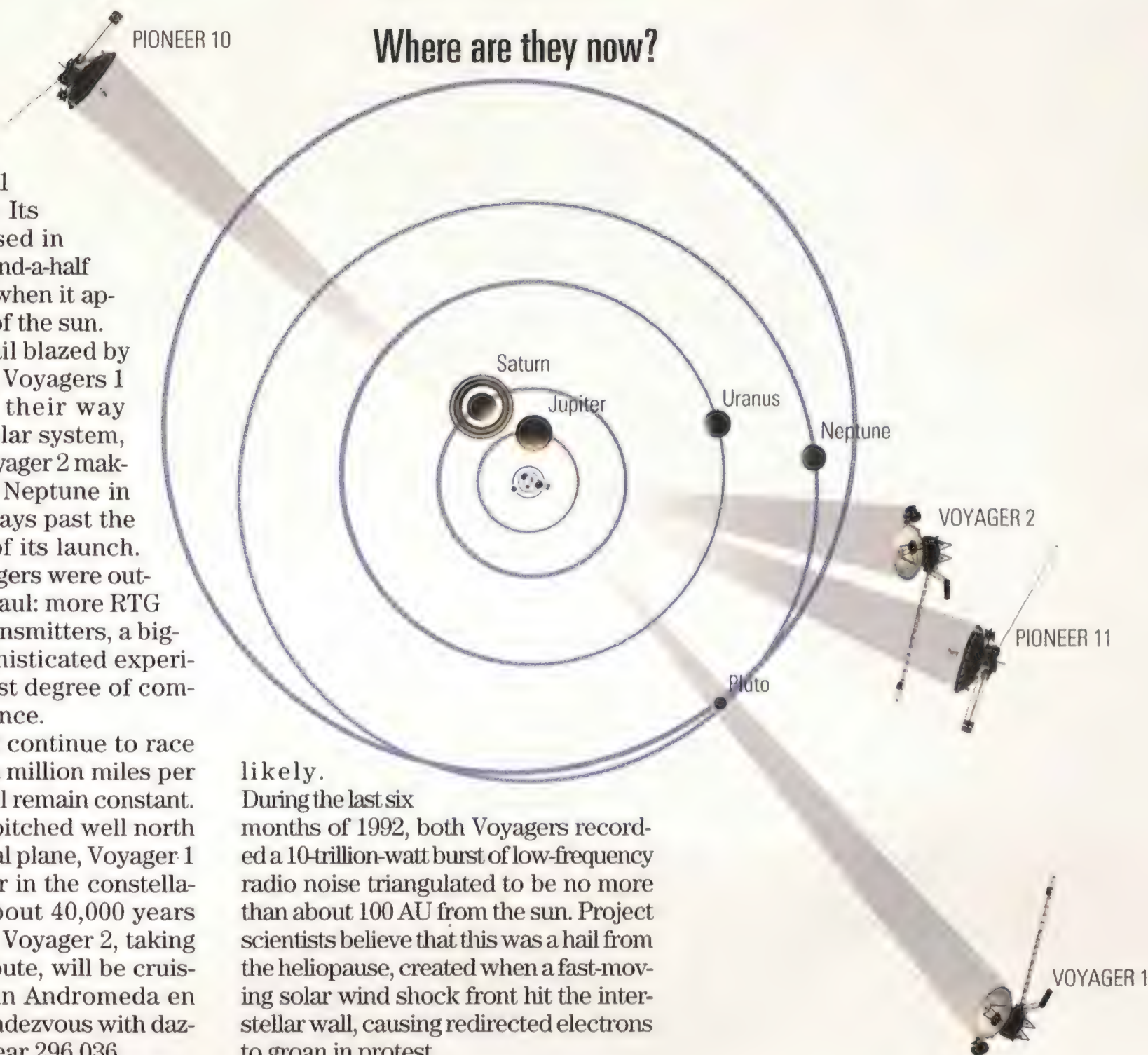
theory their RTGs would keep electricity flowing for a dozen years or more. Pioneer 11 was the first to go: Its transmissions ceased in November 1995, 22-and-a-half years after launch, when it apparently lost track of the sun.

Following the trail blazed by their predecessors, Voyagers 1 and 2 ricocheted their way across the outer solar system, culminating with Voyager 2 making a final flyby of Neptune in August 1989, five days past the 22nd anniversary of its launch. The big, beefy Voyagers were outfitted for the long haul: more RTG power, stronger transmitters, a bigger radio dish, sophisticated experiments, and a modest degree of computational intelligence.

Today both craft continue to race outward at nearly a million miles per day, a speed that will remain constant. With its trajectory pitched well north of the planets' orbital plane, Voyager 1 will pass near a star in the constellation Ursa Minor about 40,000 years from now. By then, Voyager 2, taking a more southerly route, will be cruising past Ross 248 in Andromeda en route to a distant rendezvous with dazzling Sirius in the year 296,036.

Meanwhile, somewhere not far ahead of them lies the boundary marking the limit of the sun's electromagnetic influence, a kind of Holy Grail long sought by space physicists. The first evidence of the approaching frontier should be a region called the termination shock, where the solar wind becomes contorted and redirected as it slows to subsonic speed. Bowed but not broken, the wind should limp outward until it can no longer make any headway against the tenuous interstellar ether. That will mark the heliopause, the end of the solar line, beyond which lies true interstellar space. "Our best estimate is that the distance to the termination shock is 80 or 90 astronomical units [eight or nine billion miles], and Voyager 1 will reach 80 AU in three years," says Edward Stone, Voyager's project scientist. The transition region might lie considerably farther out, but that seems un-

Where are they now?



likely. During the last six months of 1992, both Voyagers recorded a 10-trillion-watt burst of low-frequency radio noise triangulated to be no more than about 100 AU from the sun. Project scientists believe that this was a hail from the heliopause, created when a fast-moving solar wind shock front hit the interstellar wall, causing redirected electrons to groan in protest.

When and if the termination shock is reached—and conceivably that crossing could start any day now—the five experiments still working on each Voyager spacecraft will know it. Cosmic ray energies will jump, magnetic field lines will rear-end one another, and the solar wind plasma will shriek and sizzle with wave activity. "It'll be quite an exciting time," Stone says.

The Pioneer team, on the other hand, may need to be a little more patient. Even though Jupiter's gravity gave Pioneer 10 an 82,000-mph boot out of the solar system, the craft is racing toward the constellation Taurus while the sun is headed in the opposite direction, toward Hercules. So if the solar wind bubble is shaped like a teardrop, as most physicists believe, the spacecraft is unlikely to break out before its power fails. But Van Allen, whose cosmic

>>>> VOYAGER 1 WILL
PASS NEAR A STAR IN THE
CONSTELLATION URSA
MINOR IN ABOUT 40,000
YEARS. AT THE SAME
TIME, VOYAGER 2 WILL BE
CRUISING PAST ROSS 248
IN ANDROMEDA. <<<<<<<<

>>>> A ONCE-EVERY-176-YEAR PLANETARY ALIGNMENT MEANT THAT JUPITER'S GRAVITY COULD BE USED TO REDIRECT SPACECRAFT TO THE FOUR OTHER OUTER WORLDS. ON PAPER, AT LEAST, A "GRAND TOUR" OF JUPITER, SATURN, URANUS, NEPTUNE, AND PLUTO COULD BE COMPLETED IN ABOUT 12 YEARS—A FRACTION OF THE TIME REQUIRED FOR ONE-AT-A-TIME FLIGHTS. ALTHOUGH THE BILLION-DOLLAR GRAND TOUR CONCEPT WAS SCALED BACK TO A MORE MODEST PROGRAM, CALLED VOYAGER, SPACECRAFT WERE STILL ABLE TO VISIT JUPITER, SATURN, URANUS, AND NEPTUNE. <<<<<<

ray detector is the sole Pioneer 10 instrument still switched on, takes a skeptical view, arguing that the heliosphere is, in fact, nearly spherical. "What we're looking for is the absence of fluctuations caused by the sun," he explains.

Of course, all that conjecture becomes moot if no one ever hears again from the "Gallant Lady," as O'Brien's TRW team once christened Pioneer 10. The spacecraft is now 7.1 billion miles from Earth, requiring a round-trip communication time of 21.3 hours. Ric Campo and Paul Travis, members of Lasher's now-disbanded mission team, have been tending to Pioneer 10's needs on a voluntary basis for years. Now they're hoping for another chance to slip back into their old control consoles and pull in just a little more of its data.



Voyager 1 sails past Jupiter.

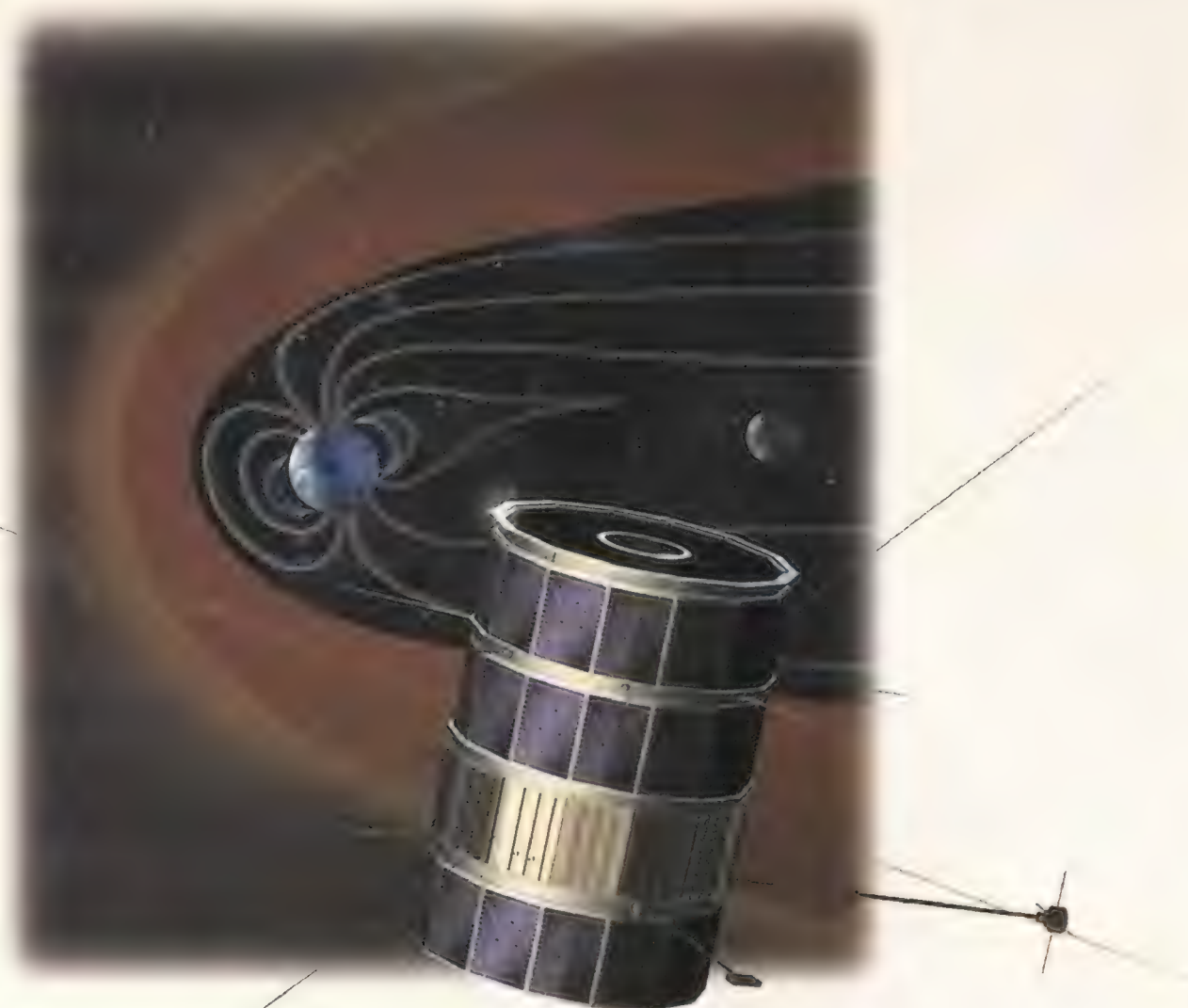
Campo and Travis attempted to tweak the spacecraft's orientation last July. Although Pioneer 10 relayed some data to Earth a month later, it never confirmed that the command was received or executed. The probe's silence could have been the result of a transmitter failure or a drop in voltage from its plutonium-powered RTGs. But Lasher suspects that the craft was simply pointing at the wrong spot in Earth's orbit. Last March, NASA's Deep Space Network tracking stations in California, Australia, and Spain began to listen for the craft's eight-watt signal, and two-way communication was attempted in

April. On the 28th, the Madrid station achieved contact with Pioneer 10.

So could the 29-year-old spacecraft become the first to send a signal from the heliosphere? Unfortunately, Pioneer is last in the queue for Deep Space Network tracking passes. Officially, the project ended on April 1, 1997—a few weeks after a "celebration" of Pioneer 10's silver anniversary at the Smithsonian's National Air and Space Museum. "It was a funeral service," Van Allen snips, "and I gave a eulogy." But he also worked the hallways, protesting the cutoff to NASA officials. They responded with a reprieve, agreeing to let engineers use the spacecraft's weakening signal to test a new tracking scheme based on chaos theory.

IMP 8 doesn't have to compete for time on the Deep Space Network, ironically, because its telemetry system is obsolete. For more than 28 years, this oldster has been continuously transmitting six kilobits of data per second—it has no tape recorder—at the long-abandoned VHF frequency of 137.98 megahertz. The signal is gathered by a trio of Yagi-style receivers (think of rooftop TV antennas on steroids) in Virginia, Belgium, and Australia that are dedicated to the IMP 8. "One of the most challenging aspects of my job," says project scientist Joseph H. King at NASA's Goddard Space Flight Center in Maryland, "is cobbling together the VHF ground network." Once at Goddard, the IMP data is routed to science teams around the country, arriving as an encrypted jumble of timing code, spacecraft positions, and instrument readouts that takes a lot of massaging by decades-old software to be useful.

But space physicists aren't complaining. The 10th and last of the Interplanetary Monitoring Platform series, IMP 8 circles Earth in an unusually high orbit that extends about halfway to the moon. In its heyday the spacecraft served as something of a sentinel, warning of stormy conditions in the solar wind. Seven of its 11 experiments still work, and their data remains a staple for hundreds of space physicists studying the sun and Earth's magnetosphere despite the advent of state-of-the-art solar watchdogs like the Advanced Composition Explorer and



IMP 8 studies solar wind.

Wind spacecraft. "It's so much a part of the culture," observes MIT's Paularena. "We accept and use its data without really thinking about it." For example, on July 14, 2000, the sun uncorked an eruption so powerful that the solar wind's shock wave disabled some sensors aboard Wind. But IMP 8 took it in stride, sending back readings on the titanic shock that had the MIT team fist-pumping in exultation.

Interest in IMP 8 data soared during the mid-1990s, when there was a hiatus in solar wind coverage by other spacecraft. But the craft's steeply inclined orbit kept it hidden from the ground stations in Virginia and Belgium for five days out of each 12-day circuit. King had been running the program on a shoestring for years, and his options were limited. But then came a chance conversation with a fellow runner at Goddard. "How's that old spacecraft doing?" asked Michael Comberiate, who had built some of IMP 8's electronics early in his career. It turned out that Comberiate would be returning to Antarctica in a few months to

service some NASA hardware, and a plan was hatched.

Working with a local Ham wizard named Michael Staal, Comberiate fabricated eight 30-foot VHF antennas, shipped them to McMurdo Station, and mounted them atop a 65-foot-high tower. Throw in some kluged electronics and a desktop computer, and—*voilà*—IMP 8 data started streaming into Goddard from the South Pole. "Antarctica is a tough place to do anything like that," Comberiate says, and after two harsh winters he disassembled the antennas and moved them to Australia.

Time is slowly catching up to IMP 8, and its data isn't as prized as it once was. Last year's loss of its magnetometer, whose magnetic field readings provide a context for other data sets, didn't help. "Right now it's like someone who is red-green colorblind," Paularena explains. "You can still see the world, but you're missing something." The continuing value of IMP 8's data will be tested later this year, when King will defend his program before a senior review board. Despite its

loss of compass, there are good reasons to keep listening to what IMP 8 has to say—if for no other reason than to extend its unbroken 28-year run of solar wind data. "Sometimes I think NASA hasn't taken sufficient pride in its long-term spacecraft," King says.

In fact, in a world where a good VCR might last eight or 10 years, NASA's endurance records seem nothing short of astounding. Budgets permitting, IMP 8 could continue sending its solar weather reports for years to come. The twin Voyagers could prove equally durable (the Voyager Interstellar Mission, as it's now called, has a timeline that runs at least through 2016). No other nation's spacefaring efforts come close to these milestones. Giotto, launched in 1985 by the European Space Agency, was tracked after plunging through two comets (Halley and Grigg-Skjellerup) until September 1992. Sakigake, another Halley watcher, remained in contact with Japanese controllers for a decade.

But the Methuselah prize may ultimately go to a spacecraft that will spend the next decade in electronic hibernation. Today NASA calls it the International Cometary Explorer, or ICE, but when launched in 1978 it was christened the International Sun-Earth Explorer 3. Under the direction of trajectory master Robert Farquhar, of the Johns Hopkins University Applied Physics Laboratory, ISEE 3 spent five years flitting here and there around the Earth-moon system. For a while it hovered near the L1 Lagrangian point, a million miles in the sun's direction; then it crisscrossed Earth's magnetosphere and lingered downstream for months at a time. Recast and renamed as a comet chaser, ICE dashed off to intercept the ion tail of Comet Giacobini-Zinner in September 1985.

The consummate trajectory junkie, Farquhar is never bereft of clever uses for spacecraft (see "Hang a Right at Jupiter," Dec. 2000/Jan. 2001). He plans to revive ICE in 2010, direct it to within 125,000 miles of Earth four years later, and have it pay a return visit to Comet G-Z in 2018. He's planned the comet encounter for September 19—a month past ICE's 40th anniversary in space. Mark your calendars. ➔



The Detroit Airlift

This hard-working band of
pilots and fleet of weary
airplanes keep the U.S. auto
industry rolling along.

by Mark Huber Photographs by Chad Slattery



USA Jet employs a fleet of Dassault Falcon 20s to ship auto parts across the country.

The man had a six-inch butcher knife and he wanted to go to Washington, D.C.—immediately. The knife was aimed at the ribs of Conrad Kalitta, famous for his hard-charging drag racing career and the founder of what was then, in 1989, one of America's most successful on-demand air freight companies. The man with the knife, Allen Stahl, marched Kalitta out to the flightline at the Willow Run airport in suburban Detroit and pointed to a Learjet that had been converted to haul cargo. It wasn't Kalitta's but Stahl didn't care. He told Kalitta to forget about the pre-flight—get in and crank the engines. Kalitta complied. He had a plan.

Kalitta's intention had been to get airborne, don an oxygen mask, and depressurize the cabin, which would have caused Stahl to lose consciousness. But once the two men were inside the Lear, all hell broke loose. Stahl began swearing, swinging the knife around the cockpit, and reaching for the throttles. Kalitta exploded and attacked with bare hands, sustaining minor cuts. Meanwhile, outside, a mechanic flung open the Lear's door and a state trooper drew down on Stahl, who promptly surrendered.

Some 12 years after it happened, the "Connie and the knife" incident is retold with relish and often much embellishment by line freight pilots based at Willow Run, who primarily serve the just-in-time parts needs of the U.S. automobile industry. Theirs is an unabashedly unglamorous existence, flying 50,000 tons of freight every year in approximately 200 gutted Learjets, Dassault Falcon 20s, DC-9-32s, Lockheed L-188 Electras, CASA 212s, and other airplanes well past their prime. The swashbuckling image of a freight pilot created by actor Mel Gibson in the movie *Air America* is largely nostalgia now. "It's not two guys off in the jungle bouncing around upside down half the time," says Jeff Anderson, a Falcon pilot and general manager of flight operations for Willow Run-based Reliant Airlines.

The operators have carved out a profitable niche delivering freight

that must arrive at its destination in a matter of hours. When a factory needs auto parts to keep assembly lines open, overnight on Federal Express is rarely fast enough. Other airports around the country, notably El Paso, Kansas City, Memphis, and Toledo, also do a thriving ad hoc air freight business for the auto industry. But Willow Run has the nation's largest concentration of operators and activity. And the self-made Kalitta remains its most colorful character.

Kalitta started flying auto parts for Ford in 1967 with a twin-engine, piston-powered Cessna 310. By 1995 *Forbes* estimated Kalitta's holdings at more than \$250 million. His investment had blossomed into an empire: five companies employing 3,000 workers and generating \$450 million in annual sales. Measuring by fleet size, his company was the world's 25th largest airline, and his airplanes hauled everything from professional basketball players to rock stars' concert equipment.



Conrad Kalitta started flying auto parts for Ford in 1967 with a twin-engine, piston-powered Cessna 310. By 1995 *Forbes* estimated his holdings at more than \$250 million.

By 1997 Kalitta's empire had fallen on hard times. In a cash-and-stock swap, it was taken over by Kitty Hawk, a much smaller air freight company. What started as a risky strategy under the best of market conditions came completely unglued as jet fuel prices spiked and wages increased in the wake of a pilot shortage. On May 1, 2000, Kitty Hawk filed for bankruptcy. Said one Willow Run insider of the deal: "Jonah swallowed the whale." Five months after the bankruptcy filing, Kalitta bought back the troubled company for \$10 million.

Kalitta's near-hijacking cemented his place in Willow Run's colorful lore. His company's history also symbolizes how rough-and-tumble the on-demand freight business can be. Two companies have since emerged as the leaders: the Active Aero Group and Reliant Airlines.

"It was truly a pilot's industry in the '60s, '70s, and '80s," says Ray Mundt, assistant director of operations at Active Aero, currently the automotive industry's largest single supplier of airlift services. Speaking of those times, Reliant's former director of operations, Paul Stephenson, says, "The old way you learned by doing it. If you came out clean and unscathed, you lived to do it another day." Preston Murray, president of Murray Air and another old Willow Run hand, agrees. "The wild days ended in the 1980s," he says. "There was a time when we didn't close this airport in bad weather." (There were two fatal air freight accidents in 1987 alone.)

Murray remembers the unfashionable 1970s at Willow Run, when freight pilots who were part of first-up and second-up crews lived at the airport in spartan rooms above the hangars with the bare amenities—bunks, hotplate, and a black-and-white television. They would "borrow" the shower at the airport firehouse. "On a big weekend you would get a room at the Howard Johnson and then sit around the hotel restaurant with fellow pilots talking about airplanes," says Murray. "There was an underlying competition to see who knew more



"There was a time when we didn't close this airport in bad weather," says Preston Murray, a longtime player in the Detroit Airlift.





At Willow Run Airport in Ypsilanti, Michigan, cargo is loaded at all hours of the day and night.

Until early last year, Kalitta's airplanes (below) made deliveries around the globe. The company was taken over by a smaller airline during a difficult period in which fuel prices and pilots wages both rose. Thereafter, the new company declared bankruptcy.



about aircraft systems."

Today pilot hygiene may be better, but life on the line at Willow Run still lacks cachet. Some of the roads around the airport retain a rustic charm—and an absence of pavement. Most of Willow Run's cargo haulers operate out of the old faded brick airline terminal and hangar complex that once served as a center for modifying and repairing B-24 bombers during World War II. Nearby is the 50,000-employee bomber factory that Henry Ford built. The factory has long since stopped building aircraft, but its productivity has never been matched.

Now it is the training of freight pilots that is conducted with wartime efficiency. Favoring regimentation, instructors torture pilots with compound aircraft-system failures in full-motion simulators. Some of these pilots fly regular, scheduled runs, but most of them live "on the beeper," with a packed suitcase at the ready and a mandatory 25-minute response time to the airport. They could be gone for four hours or four days, and may not know for sure until they are airborne or until they land at their first destination.

"I always take a suitcase with me," says Terry Wilmott, a Falcon 20 captain for USA Jet, Active Aero's in-house freight airline. When his beeper goes off, Wilmott could be headed for Kansas City—or Kuwait. Chances are the destination airport would never make the pages of a travel magazine. In the years following passage of the North American Free Trade Agreement, border towns and trade gateways such as El Paso and San Antonio, Texas, Tuluca, Mexico, and London, Ontario, have become frequent stops. Memphis, Tennessee, home of FedEx and convenient to the auto assembly and auto parts plants of Tennessee and Kentucky, has become a secondary hub for Reliant.

"Our job is to manage chaos," says Reliant's founder and president, Rick Zantop, a 30-year veteran of the Detroit airlift. "It asks an awful lot of the pilots." Zantop started flying auto parts for his father in the 1960s and



"We know where we are on the food chain."

—ACTIVE AERO CHIEF OPERATING OFFICER BRIAN HERMELIN.

founded Reliant in 1984 with a handful of Falcon 20s converted to haul cargo then jettisoned by Federal Express. "It's a simple business," says Zantop. "We are expected to do the impossible on no notice."

"It's a total emergency when the phone rings here," says Brian Hermelin, Active Aero's chief operating officer. Hermelin, a 35-year-old Wharton Business School MBA, speaks in Wall Street staccato as he stands in the center of Active Aero's computerized command center. Forty-three people work in here. The monitors display live Internet auctions that are under way on jobs Active has put out for bid. Active is both a freight hauler and an air freight broker, and counts Ford Motor Company as one of its largest customers. When Ford's auto parts supply chain is threatened with interruption, Active gets the call. It immediately puts the job out on its proprietary computer network to a list of pre-qualified air freight vendors. Active's own charter subsidiary, USA Jet, is among them. The entire process is heavily price-driven and not unlike a consumer Internet auction that one might find on eBay. Only in this case, the low bidder wins. The system is transparent and Ford and the company's other clients can monitor the auction in real time to ensure that they are getting the best available price. For the jobs it



“Our business model is the **Strategic air Command**—with ready-alert crews.”

—ACTIVE AERO CHIEF EXECUTIVE OFFICER
MARTY GOLDMAN

brokers, Active takes an undisclosed cut off the top, not unlike a stockbroker's commission.

Indeed, the command center more closely resembles a brokerage house's trading floor than an air freight dispatch operation. Some deals close in as little as two minutes. Giant video screens on the walls display tracked flights with weather depictions overlaid. Following Kitty Hawk's bankruptcy, Active has become the largest air freight charter manager in North America. It also operates its own fleet of Falcon 20s and DC-9s through USA Jet Airlines. “Our business model is the Strategic Air Command—with ready-alert crews,” says Hermelin's partner and Active Aero's chief executive officer, Marty Goldman, a lawyer lured out of retirement. During the Korean War, Goldman flew C-119s manufactured by Kaiser-Fraser. (Kaiser took over

the Ford B-24 plant after World War II.) Last year USA Jet flew three million miles and Active Aero managed an estimated 20,000 charters, a 15 percent increase from 1999.

Automobile industry executives prefer to downplay the role of ad hoc charter in keeping their assembly lines running. Bill Storves, North American supply manager for vehicle operations and power trains at Ford, will only say that just-in-time charter business accounts for “less than one percent” of the company's transactions. And the charter operators themselves do not wish to discuss the economics of the service they provide, though one industry insider estimates that flying parts ad hoc contributes \$300 to the cost of each vehicle made by General Motors, Ford, and Daimler-Chrysler.

Sending a Falcon 20 into the night can cost up to \$5 per statute mile,

A walk around Willow Run turns up a variety of old but functional aircraft, such as this CASA 212.





After taking on a load in Pontiac, Michigan, USA Jet pilots Ulrich Vranken (left) and Ryan Speece begin their takeoff roll in the rain.

Zantop International relies on Lockheed L-188s to get supplies to customers.



but the costs of shutting down an automobile assembly line (the specifics of which auto executives will not discuss) make this look like a bargain. Marty Goldman of Active Aero has seen his airplanes met by helicopters that fly the parts directly to the stricken plant in a scenario that seems more like medevac than air freight. Describing his company's mission in supporting the automotive plants, Rick Zantop chooses words

you would expect to hear from a paramedic: "You have to get them the parts before it happens, before the patient dies."

At 2:25 on a rainy Monday afternoon, 10 minutes after Active Aero gets another "total emergency" call, USA Jet pilot Terry Wilmott's home phone rings. At 2:45 Wilmott is met in Active Aero's operation center by first officer James Gosslin, who recently joined the company after 21

years in the military, 10 of them, some 3,100 hours, flying AH-1 Cobra helicopter gunships and C-12 King Air turboprops. Wilmott, with 6,700 hours of total time, ascended the ranks as a civilian, first as a flight instructor, then as a corporate pilot. He has served as a Falcon 20 captain for a little over a year and is getting ready to transition to DC-9s. The two men have never flown together before. This is not an uncommon situation at USA Jet, which will employ more than 140 pilots by year's end. "In the old days," says Wilmott, referring to the 1980s, "there were ten different ways to fly the airplane." Thanks to standardized training, "now there is just one." This allows Wilmott to fly with Gosslin, a total stranger, with confidence.

The pilots are briefed on their mission: Fly 220 miles to Indianapolis, pick up several pallets of General Motors power steering pumps, take them 327 miles north to London, Ontario, then fly a 126-mile leg home. On paper, it's an easy trip. Weather, however, doesn't respect paper. Wilmott heads for a waiting Falcon 20 with his rollaway suitcase and notebook portfolio. An ominous red sticker has been plastered to the portfolio's cover: "Shipment Contains Human Remains, Handle With Care" (freight dog humor). Wilmott completes the preflight in the rain, clutching a windblown umbrella with more than a few exposed spokes.

The crew is buckled in by 3:17 and the Falcon's 74-inch-wide cargo door is lowered into place. It does not seal tightly; daylight comes in around the edges, and the aircraft's pressurization system will be working overtime to make up for the leakiness.

Wilmott hits the igniters, lets the engines run, and checks the air brakes. USA Jet no. 816 taxis out to five miles visibility in mist on Runway 5 Right. (At 7,526 feet, it is the longest of Willow Run's five runways.) By the time 816 gets to Indy, there will be an excellent chance of thunderstorms there.

At 3:27 Wilmott advances the throttles as Gosslin reads the takeoff

speeds. Wilmott rotates at 154 mph, lifts off, and quickly enters the base of an overcast at 10,000 feet. Just as soon as the cruise checklist is done, it is time to head down again, into Indianapolis Center's airspace.

Things happen very fast in the Falcon; it is definitely a two-man airplane. The instrument panel is old and crowded but very functional. "The Falcon 20 is a very strong airplane," says Rick Zantop, "It's a small airplane, but it's not a toy." Cargo-configured 20s can fetch \$1.5 million to \$2 million, and those who operate them at Willow Run, primarily Reliant and USA Jet, run them hard, about 1,100 hours per year per airplane. With 5,700 pounds of freight in the back, a 20 can fly for an average of 1.5 hours with fuel reserves at about 450 mph. Most loads, however, weigh far less.

Rick Zantop was one of the first operators to see the value of Falcon 20s as on-demand cargo haulers after FedEx moved to larger aircraft for its overnight package service. Along with DC-9s, he calls them the backbone of the auto industry's



The temperature hovers just above freezing as a worker loads automobile trim parts into a DC-9 that will soon play its role in keeping auto assembly lines moving.



"There's **nothing** in this business you can rely on. You may be told that you are taking on **one** pallet and you **get** four."

—PILOT TERRY WILMOTT (RIGHT) WITH
COPILOT JAMES GOSSLIN

airlift. Today they are operated in quantity not only by Reliant and USA Jet but also by Toledo-based Grand Aire and Dallas' Ameristar. Several other operators have two or three each.

Typically, the six to eight operators who provide the vast majority of Detroit's airlift trade airplanes and parts among themselves or scoop them up from bankrupted brethren. The rising fuel prices and pilot shortage of 1999 combined to chase several marginal along with a few well-known operators out of the marketplace. "Most of our aircraft come from companies that no longer exist," says Zantop. "There is a high failure rate of companies in our industry." At least two of USA Jet's Falcons were previously registered to Kalitta. Airplanes gleaned on the cusp of a creditor auction typically require few modifications to convert them to freight haulers, as they are already configured for cargo. Generally,

avionics must be added, subtracted, or relocated to satisfy fleet standardization requirements. (Converting a passenger-configured Falcon 20 to cargo costs \$500,000 and up, largely due to the airframe modifications required for the large cargo door.)

Big cumulonimbus cells are forming on the left side of the airplane as 816 drops through 4,000 feet and slows for landing. Wilmott and Gosslin touch down at 4:30 p.m.

A forklift with three pallets holding 1,893 pounds' worth of power steering pumps is waiting on the ramp. The air is dripping with humidity. Wilmott heads into the freight terminal to recheck the weather and file a new flight plan. Gosslin fetches his heavy duty cargo mitts from the airplane's storage locker and hooks up the cargo straps to the pallets. Sweat pours off the beefy Bostonian's brow as he and the fork driver push the load into the rear of the aircraft.



"There's nothing in this business you can rely on," says Wilmott. "You may be told that you are taking on one pallet and you get four." By 4:45 816 is loaded and ready to go—almost. U.S. Customs must clear the departure, and Customs is nowhere to be found. After 25 minutes, an inspector finally arrives and saunters casually toward the aircraft. Wilmott and Gosslin know better than to appear annoyed or anxious. No amount of pilot agitation will convince the bureaucracy of the Detroit Airlift's urgency. Schmooze mode prevails.

By 5:45, 816 is loaded and legal. Gosslin will fly this leg. After liftoff, 816 is cleared to 16,000 feet and vectored right into a large bank of towering cumulus clouds that is turning the onboard weather radar's screen ominous shades of crimson. Wilmott calls air traffic control to ask for a turn, but the frequency is clogged. Turbulence begins to buffet the Falcon, followed by sheets of rain that pelt loudly against the fuselage. With the Falcon penetrating the precipitation at 288 mph, the

raindrops sound more like hail. Gosslin and Wilmott confer and decide to turn left 20 degrees before things get any more interesting. Rain follows 816 all the way to London, where it lands at 6:45. A delivery truck and Canadian Customs are waiting; fifteen minutes later the forms are signed and the Falcon is unloaded. The power steering pumps will make it to the plant on time.

Wilmott, who will fly the short leg back to Willow Run, opts to take on 3,000 more pounds of fuel ("The only time you can have too much gas is when you are on fire," he says). Due to air traffic control vectors for traffic and weather, the short 126-mile trip will take a lot longer than the pilots think. Flight 816 breaks out of the overcast 350 feet above the runway at Willow, and the pilots do not make it back to the USA Jet ramp until 9:00 p.m.

"Nobody in this business ever says 'thank you,'" says Reliant's Rick Zantop. "The pilots are worked very hard." (They fly an average of 800 hours a year with additional hours spent on-call.) "We know where we are on the food chain," says Active Aero's Brian Hermelin. The freight pilots are not on the bottom, but close to it. Last summer United Airline pilots ratified a new contract that will pay senior captains more than \$300,000 per year with a fixed

schedule. Senior captains of the Detroit Airlift can make around \$135,000 with overtime and incentive pay. Instructors and check airmen can conceivably boost that to \$150,000. A first officer starting off on the Falcon will make around \$32,000 a year.

Then there's the stress and uncertainty of living life at the beck and call of the beeper. "You can't guarantee the schedule at this company," says Active Aero's Ray Mundt. His pilots and those at other companies are often asked to work scheduled days off. In 1999, the red-hot auto market stretched the Detroit Airlift to the breaking point. "Automotive consumed all available lift," says Zantop.

Zantop is standing in his hangar where, during World War II, B-24 Liberators once ruled. Between 1942 and 1945, Ford made 8,685 of the bombers here at a giant 3.8-million-square-foot factory across the field. The building is now occupied by General Motors' Hydramatic plant. "It's for the love of flying that we do this," says Zantop. He looks out at a Lockheed Electra taxiing by a parked Airbus chocked perpendicular to one of his Falcons. When Charles Lindbergh visited Willow Run in 1943, he called it "the Colossus of American industry."

It still is. —



A picked-over DC-9 is a source of parts for DC-9s sound enough to fly freight.

Comm

A More Perfect Astronaut

With new techniques in genetic experimentation, can biologists make harder space dwellers?

Even when one is inside a climate-controlled spacecraft, sheltered from the deadly vacuum outside, space is a hostile setting. Terrestrial organisms venturing off the planet face a number of threats, chief among them cosmic radiation and the near absence of gravity. In space, medaka fish become disoriented, turning continuous somersaults as they swim. Rats cease to use their hind limbs effectively. For humans, problems include the wasting of postural muscles, the demineralization of bone, and the often disquieting sensation of being upside down.

These well-documented physiological changes seem tolerable for short stays in Earth orbit. But what happens to a species after reproducing in space for many generations? On a space station, colonies that have no precedent for living without gravity will change in fundamental ways. Responding to any new environment involves not only visible changes, like shivering in reaction to cold, but also changes in the pattern of gene expression—the way genes turn on and off—in body tissues.

From the human genome project, we have learned that about 35,000 genes encode a human being. What most people don't know is that only a fraction of these genes are actually turned on or expressed in any given cell. The genes that are turned on in brain cells, for example, are different from those active in muscle or kidney cells. Gene expression can also reflect the response of the cell to the environment. Start jogging or experience the muscle wasting of space, and gene expression in the affected muscles will change.

New "gene chip" technology can re-

veal changes in thousands of genes at once, and is revolutionizing understanding of the mechanisms of gene expression. The same technology will prove a powerful technique for studying how organisms react to being on the International Space Station.

Some of the genetic response will be immediate, as is experienced when

If we envision the creatures that might evolve over very long periods, it wouldn't be surprising if hindlimbs diminished to vestigial stubs and forelimbs gained adhesive properties. Who needs Velcro when your hands are sticky?

a person on Earth begins jogging. But for long-duration space colonies, a second, slower force will come into play—natural selection. It's fun to speculate (which is all we can do right now) on what kinds of traits might turn out to be adaptive for species living off-Earth for multiple generations.

Very simple genetic changes can result in major rearrangements of an organism's body plan. Animals are made

of modular units, like appendages or eyes, controlled by master genes through which entire body parts can be duplicated, removed, modified, or shifted in location. Minimal changes in a single critical gene can therefore produce large changes in an animal's appearance. Over the course of evolution, alterations in master genes have transformed a limb into a wing and a starfish's tube feet into a lobster's claw. The near absence of gravity on the space station will likely exert selection pressure on these control genes. If we envision the creatures that might evolve over very long periods, it wouldn't be surprising if hind limbs diminished to vestigial stubs and forelimbs gained adhesive properties. Who needs Velcro when your hands are sticky?

We can look to certain oddball organisms on Earth for clues as to what kinds of genes might be helpful to species in space. A species of bacterium called *Deinococcus radiodurans* can withstand 3,000 times as much radiation as people can. In humans, high radiation levels damage cells by breaking long, continuous strands of DNA. Radiation causes similar damage to *D. radiodurans*, but within hours the DNA is correctly reassembled. For every other known life-form, any attempt at DNA reassembly would be so fraught with errors that the organism would die. But *D. radiodurans* has somehow solved this problem, and its genome—the complete set of its DNA—may be a treasure chest of genes that could protect other organisms facing high radiation levels.

How could these genes be put to practical use? Fortunately, the interrelatedness of all species allows the same genes to function identically even in highly unrelated species. In a process called lateral gene transfer, many genes have jumped species over the course of evolution. In fact, tucked into our own human genome are a number

century

by Kenneth S. Kosik

of genes that appear to have jumped in from bacteria.

In addition to physical traits, social relationships among animals can have a genetic component. Some male mice, for example, tend to be deadbeat dads, with little interest in caring for their young. Researchers recently have shown that if you take from a prairie vole a gene for something called the arginine vasopressin receptor and transfer it into a mouse, you can produce male mice that, like the voles, stick more closely by their offspring. A simple genetic change leads to a profoundly altered behavior. Could such knowledge be useful for humans, many of whom have trouble spending long periods in isolation, whether in Antarctica or on a three-year trip to Mars?

The bad news for experimentalists is that evolutionary change, even in fast-reproducing species, takes time. How can we study long-term adaptation to space without waiting decades? The answer lies in understanding the deep and profound basis of the evolution. First and foremost, evolution is based on genetic diversity. In humans, the actual DNA sequences, or strings of letters we call the genetic code, differ slightly from individual to individual. These small differences are thought to contribute to, among other things, variations in susceptibility to illnesses such as Alzheimer's disease, diabetes, and cancer. This is true for other species as well. If 100 rats are placed on the space station, minor differences in their genomes may contribute (along with many other factors, from cage design to nutrition) to their reproductive success. The space station will, for the first time, allow us to watch living or-

ganisms adapt to space over generations, and to see which ones do better and which do worse.

Which organisms will make the best test subjects? To watch evolution in action, we need species with short reproductive periods, such as yeast. It also will be useful to study creatures whose genome is known. The list of species whose genome has already



DAVID POVILAITIS

been crudely mapped include the fruit fly, a small worm called *Caenorhabditis elegans*, the wild mustard weed, numerous single-cell organisms, human beings, and soon the mouse and zebra fish. And because sequencing the entire genome of any organism is no longer a formidable task, we shouldn't limit ourselves to the few species most often studied by biologists. For NASA's purposes, it might make sense to sequence other organisms that hold the potential of becoming well adapted to space. For example, certain fish create an electric field around them, which

they use to detect the presence of intruders. Knowing whether a visitor has entered the field requires a memory of what was previously in the field. And locating the disturbance caused by the intruder requires a set of coordinates related to the orientation of the creature's body. Will this mechanism work just as well when gravitational orientation is lost? Experiments to test ques-

tions like this could yield profound insights into how weightlessness affects both the genetic and physiological bases of spatial learning and memory.

The ability of engineers to build vehicles and space stations that can safely house humans and other species in Earth orbit, or on a voyage to Mars, opens a new biological niche into which life can radiate. With advanced techniques in genetic research arriving at the same time that a sophisticated laboratory is being assembled in Earth orbit, the tools are finally in hand to explore this subject in earnest. The collected genomes of all species, with their staggering diversity, plus the much larger set of synthetic genomes certain to be created from this

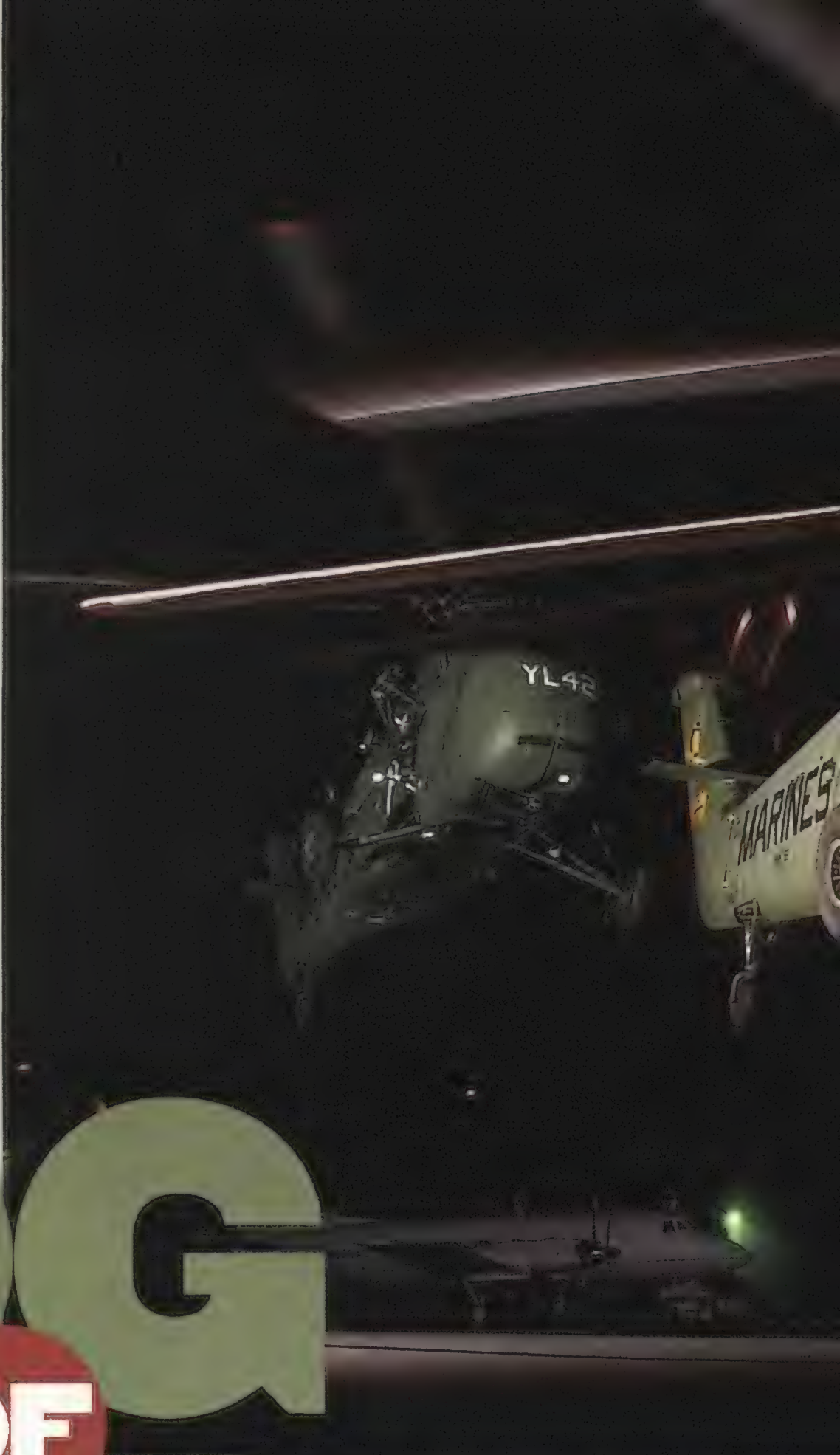
raw material, hold the potential to create life-forms capable of surviving, even thriving, in the hostile environment of space. The scientific and ethical implications of this will affect not only future astronauts, but the destiny of life on Earth.

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ITS OFFICIAL NAME WAS THE SEA HORSE, but they called the big helo the Dog. Not because it flew like one but because you'll never get a Marine to call any weapon by the name the Corps gives it. Marines use the phonetic alphabet in radio communication, replacing letters with words, and in the Korean War, well before today's NATO-compatible alfa, bravo, charlie, delta for A, B, C, D, they used able, baker, charlie, dog. Because it was the D model of the Sikorsky H-34, the UH-34D came by its nickname honestly.

The Dog I met is one of two still flying in a coat of flat Marine green. Its owner is James Moriarty, a dogged, wealthy Houston lawyer. "I sue big companies that cheat people," he says with in-your-face pride. "Erin Brockovich is my hero."

Moriarty loves the Marine Corps enough to have spent an unspeakable amount of his own money restoring the 40-year-old UH-34D so that he can operate it as a living, breathing, shuddering, fluttering, flying Marine memorial. He takes his YL-42—in GI phonetics, "Yankee Lima 42," the call sign of an actual helicopter that had a fatal crash—to airshows all over the country. It has been restored to the condition of one of the hard-working UH-34Ds that flew in Vietnam, just as it might have looked parked on the HMM-362 (HMM means Helicopters, Marine, Medium) "Ugly Angels" squadron ramp at



DOG OF WAR

Think of Yankee Lima Four Two as a time machine: Jump in and you're back in Vietnam. by Stephan Wilkinson
Photographs by Lance Cheung





Arriving early in the Vietnam War, the UH-34 was big, bulbous, and—to the Marines who flew in it—beautiful.





Soc Trang, or “Marble Mountain,” the helicopter strip at Da Nang. The cabin is cluttered with toolboxes and spares, and the slightly askew clamshell nose doors are held together with a bungee cord just as they would have been during the war. There’s a small puddle of red hydraulic fluid on the cabin floor, and even an inert M-60 machine gun on a swivel mount in the main door.

Though Moriarty served three combat tours in Vietnam, he wasn’t an H-34 pilot—wasn’t a pilot at all, wasn’t even an officer. He was a Huey door gunner. A sergeant. “We used to occasionally see the UH-34s at Marble Mountain, but I thought those old radial engines were totally obsolete,” he says. “Hell, I was flying in turbines.”

He had a point. The H-34 family marked the end of the era of piston engine military helicopter design, an era that was coffin-nailed shut by humming, vibration-free turbine engines, sophisticated and durable rotor systems, and unimaginably light and reliable materials and devices. The H-34 (Sikorsky model number S-58) was derived from the H-19 (S-55), a late-1940s Sikorsky design that pioneered a unique engine configuration. The obvious place to put its big air-cooled radial engine would have been in the very center of the helicopter,

right under the rotors and with the vertical driveshaft connected directly to them. But that would have pretty much filled the cabin.

Sikorsky’s solution was to stick the engine out in a big schnoz of a nose, with its crankshaft tilted back and the driveshaft angled up and aft, passing between the flight crew seats to the transmission and rotor hub at about a 45-degree angle. This left a boxy, unobstructed area for a cabin behind and below the cockpit.

Today, the turbine equivalent of the H-34’s 1,525-horsepower piston engine weighs about 25 percent of what the iron-mongered original did and fits nicely up above the cabin. Another example of the 34’s archaic complexity: The main rotorhead, about the size of a Stetson hatbox, has 84 grease nipples, every one of which has to be lubed before a flight. Today’s typical rotorheads—light composite sandwiches of elastomers and alloys that shrug off the torture of tons of centrifugal force from whirling rotor blades—have never seen a grease gun.



Oversize cargo came by sling (above). The main gear’s long telescoping struts softened smackdown landings. Below: YL-42 cruises near Houston over a marsh reminiscent of Vietnam’s southern delta region.

MARINE CORPS

LANCE CHEUNG



JIM MORIARTY has restored YL-42 to the condition of one of the hard-working UH-34Ds that flew in Vietnam, just as it might have looked parked on the HMM-362 "Ugly Angels" squadron ramp at Soc Trang or "Marble Mountain," the helicopter strip at Da Nang. The cabin is cluttered with toolboxes and spares, and the slightly askew clamshell nose doors are held together with a bungee cord, just as they would have been during the war. There's a small puddle of red hydraulic fluid on the cabin floor, and even an M-60 (non-functional) on a swivel mount in the main door.

LANCIE CHEUNG



MARINE CORPS

As hard as it is to fathom, the UH-34D was powered by the same Wright R-1820 Cyclone radial engine used in everything from the last Navy biplanes to the B-17s and DC-3s that entered service between the world wars. The Dog was never intended to do battle against ground troops, so UH-34Ds had no guns, no cannon, no rockets. No problem: The Marines welded up mounts for M-60 light machine guns, one on each side of the cabin, and installed them in the field. That was as much recoil as the airframe could take.

With the ascendancy of turbine engines, the Sea Horse was already obsolete by the time of its first flight in 1954, but a war spared it. Vietnam first began to heat up in the early 1960s, becoming a combat zone for lifers and professional warriors, many of them Marines. The Marines' two dozen UH-34Ds were all that squadron HMM-362 had to work with when, on April 15, 1962, they landed at Soc Trang, a former World War II Japanese fighter strip on the Mekong River delta. The Ugly Angels, as they soon came to be known for their medevac missions, were eventually followed by nine more UH-34 squadrons.

By the time the media had swarmed into the war in the late 1960s, the chattering rumble of the 34's radial engine had largely been replaced by the raspy whine of the Bell UH-1B Huey. The nightly news resonated with the pounding beat of the Huey's wide twin rotor blades, and most of us came to assume that Vietnam was the Huey's war.

But in the seven mostly un-televised years that Marine UH-34Ds were "in country," they served as everything but gunships. They carried troops, cargo, crates of ammunition that their crew chiefs kicked out the door during low passes over beleaguered landing zones, packages and paperwork on admin runs, chaplains ("holy helo" trips), bodies, and, perhaps most memorably, the wounded. Without the UH-34D's endless medevac shuttles, many more wounded U.S. and South Vietnamese troops would have died.

The Sea Horse had been designed to be a carrier-borne Navy anti-submarine helicopter, fighting a relatively neat search-and-detect sonar war at sea. Unfortunately, the aircraft's skin and such major items as the transmission case were made of superlight magnesium, which in the presence of saltwater did its best to become powder.

That magnesium was also to become a liability in battle. "On my second day of flying in Vietnam," recalls former pilot Seppo Hurme, "one of our 34s was shot down, and you could see it from miles away, the magnesium burned so bright. But you never had to worry about ending up a cripple. Between the av-gas and the magnesium, you either walked away from a crash or you died." Former HMM-363 pilot Joseph Scholle recalls, "We used to call it the world's largest flashbulb. Get a fire anywhere and drop it in the water is about all you can do."

Nonetheless, Hurme loved the old Dog. "That big engine up front was the equivalent of a lot of armor plate and gave you more protection than there was in other helicopters. I

Tall in the saddle: UH-34 pilots perched high above the cabin and, while discharging troops, felt exposed to fire from the front and flanks but not the tail.

heard of one guy who took a hit from a 57-millimeter recoilless rifle that knocked one of the cylinders completely off. The engine kept running—rough, but they still got away. When I transitioned to Hueys, I felt naked.”

The Dog’s replacement was the turbine-engine, twin-rotor Boeing-Vertol CH-46, but the 46s soon experienced in-flight failures, shedding their entire tails and tail-rotor pylons. Joseph Scholle recounts: “The H-46s would break apart right in front of the stub wings and become a section of two H-23s.” The accidents led to the CH-46’s grounding, so the Marines turned back to the faithful UH-34D. Says Scholle, “The part I grew to like was its reliability. We’d get more time out of our engines than the Hueys were getting. All that red-clay sand used to get sucked into their intakes and eat the turbine blades alive. We had an air cleaner, basically, like you have on a Pontiac. Take it out, bang it on the ground, rinse it in av-gas, and you’re back in business.”

The Dog could lose parts and survive: “It was one of the few helicopters that would fly with an inoperative tail rotor,” says Scholle. (A helicopter’s tail rotor is intended in large part to oppose the tendency of the fuselage to rotate rapidly around, and counter to, the main rotorshaft.) “A 34 has an awful lot of side area, and as long as you’re doing 45 knots, it swings around into about a 45-degree crab [angle] and stays there. It’s weird, but you can fly it.

“She’d also fly without transmission fluid,” Scholle continues. “Guys would have the transmission oil cooler shot out, the oil pressure went to zero and you’d just fly it back. You do want to keep the power up, though, because once the gearbox stops, it welds itself into a single piece.”

For their size, UH-34s were surprisingly nimble. They could get into and out of landing zones where no other helos could go, but once on the ground, the pilots were sitting 13 feet up in the air, and the people shooting at them were lying as flat on the ground as they could.

Rod Carlson was another re-routed CH-46 pilot, sent to HMM-361 to fly Dogs. Carlson drew his first night medevac mission soon after arriving at Marble Mountain, flying with Captain Rod Sabin. Wounded Marines who medics feared would die in the field before daybreak were flown out, but it was a dangerous undertaking. Carlson and Sabin waited for a summons in the squadron ready room, where, “with the red lights on to preserve our night vision, everything was the color of clotted blood,” Carlson recalls.

When the phone rang, Sabin and Carlson sprinted to their 34 and fired it up. “A constant blue-white flame from the exhaust stacks extended past my window like a huge blowtorch,” Carlson recalls. “Once we were airborne, Sabin flipped off the light switches overhead, and except for the flame, everything vanished in total darkness. I felt as though I were in free fall.”

Below them, Carlson says, “lights blinked like the small farms we flew over during night hops from Pensacola. But each [light] was the muzzle flash of a gun being fired at us.” The LZ—landing zone—was hot, so Sabin told the grunts on the ground to mark its center with a small strobe.

“The standard procedure was to spiral down directly over the LZ, in order to present the smallest target for the shortest time. In daylight, this approach was dangerous. At night,



Sikorsky's H-34 Sea Horse

Derived from the Korean War-era H-19 (ghost image), the larger, stronger H-34 was designed around its predecessor’s propulsion arrangement, with a large radial engine in the nose, its crankshaft canted upward and to the rear. It had a lower, stouter aft fuselage and an airplane’s traditional tailwheel landing gear, which gave the 34 a longer and wider stance than that of the 19, with its tighter four-legged-barstool arrangement.



FINALLY, THE SQUADRON

SKIPPER could take no more. He

announced that he was going for a ride, and

if anyone wanted to join him, he wouldn't

stop them. The entire squadron fired up and

headed for the valley. The skipper and three

other 34s were immediately shot down. It

was late, so the surviving helos returned to

Phu Bai. First thing the next morning, the

Angry Eyes returned to the landing zone and

began pulling out soldiers.

MARINE CORPS

I was sure it was impossible." Carlson remembers that Sabin dropped the collective to the bottom stop to reduce the pitch on the blades to zero, cut the throttle, dropped the nose, and spiralled down like a duck with a shot wing. "After five complete revolutions he straightened out," Carlson recalls, "and the strobe was dead ahead. I could feel him raising the nose to slow our forward movement and twisting on full power to stop the descent."

Sabin maneuvered to put the strobe between the helicopter and the waiting Marines, but the light kept moving: The Marine carrying it had mounted it on his helmet, figuring that would make it a better beacon, and now he realized Sabin might try to land on top of him. "Rod landed with his side toward the shooting, so the exhaust stacks wouldn't be a target, and we picked up our guy," says Carlson. "I remember as we headed back toward Marble Mountain, Sabin got on the intercom and asked the corpsman down in the cabin, 'How's he doing?' The medic said, 'I've got my hand inside his chest, but he'll make it.'"

Before the end of Carlson's first night aloft, he and Sabin would do it 11 more times, a typical shift for a ready-when-you-are Dog.

Ron Ferrell was also a corpsman on UH-34Ds, and he and many another pilot particularly appreciated the big, fat wheels and tires mounted on gear struts with generous travel to absorb heavy landings. "We were lifting off under fire one day," Ferrell says, "and the pilot took a hit in the head just as we took off. We were nose-down, tail-up, and he had the rotors cranked up to full rpm, and then *boom*, we set right back down. We probably dropped a good 10 feet. I watched those struts go damn near to the ground and then spring back up."

On the ground, gunner and crew chief James "J.T." Nelson maintains communication with Moriarty over his helmet intercom. Nelson works a day job as line service manager for a Houston fixed-base operator.



LANCE CHEUNG



LANCE CHEUNG (2)

Copilot Steve Long swings the tailcone open to gain access to a tail-rotor shaft serviced before each flight.

John Downing, a former HMM-361 pilot, remembers that the big landing gear made it easier to get into a tight LZ. "You could stand it up and put the tailwheel on the ground, haul back on the cyclic, and get it about 40 degrees nose-high; just put the tailwheel on the ground and it'd stop on a dime," he says. "That got me in trouble when I transitioned to the Huey, because you definitely don't want to do that in a UH-1. The first thing that hits is the tail stinger; next is the tail rotor."

H-34s were the first helicopters to get a true stability augmentation system, called the ASE, for "automatic stabilization equipment," a kind of primitive autopilot that did its best to counter a helo's tendency to do anything but fly straight and level. When it was working, it created a stabilized feeling; when it wasn't, they just flew without it.

Well, they did if they were sharp stick-and-rotor guys. HMM-362 door gunner Bobby Johns recalls, "There were pilots who wouldn't fly it if the ASE was not engageable. It's a hands-on bird, and with the ASE working, you could set the trim and actually turn loose of the controls."

The aircraft is extremely sensitive to the controls. Just think about doing something and you've already done it, pilots say. It took a lot of coordination to manually adjust the engine rpms with the motorcycle-grip throttle on the collective that controlled the blade pitch. You could overspeed it quite easily, so you had to listen to the sound of the engine and the rotor blades without looking at the gauges. Some pilots compare it to the way the barnstormers flew in the 1920s, listening to the sound of the wind in the wires.

Former crew members' affection for the Dog originates in a belief that the helicopter would get them back alive.

George Twardzik was a door gunner with the HMM-163 Angry Eyes, a squadron named for the glaring samurai eyeballs painted on the nose doors of their UH-34Ds. Twardzik remembers the day in March 1966 when an Army Special Forces unit under siege in the A Shau Valley called frantically for help. When the first helo to assist them was promptly shot down, all units were ordered to stay away from the fight. "For three days, we could hear the troopers begging over the radio for medevacs, ammo, and water," he says.

Finally, Twardzik's squadron skipper could take no more. He strode to his 34 and announced that he was going for a ride, and if anyone wanted to join him, he wouldn't stop them.

The entire squadron fired up and headed for the valley. The skipper and three other 34s in the first wave were immediately shot down. It was late in the day, so the surviving helos returned to Phu Bai to regroup. First thing the next morning, the Angry Eyes returned to the LZ and began pulling out soldiers.

Twardzik remembers his aircraft taking fire from a .50-caliber machine gun. Eventually it found them. Twardzik took a ricochet squarely on his flak jacket, and during liftoff the impact blew him out the door. His safety belt snapped him right back into the cabin, where another round hit and ignited a five-gallon can of crankcase oil. The pilot autorotated down into a clearing, where the crew pitched the flaming can out and extinguished the fire. With the engine restarted and the rotors re-engaged, they took off, dragging the main gear through the trees as they headed back to Phu Bai. "I got out of the 34 to view the damage, and the aircraft was literally sieved with bullet holes," Twardzik says. The Angry Eyes nonetheless managed to save every one of the HMM-163 air crewmen who'd gone down the day before, as well as 190 of the 220 Special Forces troops.

Moriarty's UH-34D was originally an HSS-1N he found corroding in a New England farm field. He bought it without realizing what he was in for. "I paid \$45,000 for it, figured we'd fill it with gas and fly away. What did I know?"

Moriarty himself couldn't fly it, since he had never flown a helicopter, so the hulk was trucked to a restoration shop in Tucson, Arizona. "I had no reason to believe that it was anything I could ever fly," he admits. "This is one huge, powerful, noisy, intimidating machine." But Moriarty learned to fly helos in a little two-seat Hiller and added a rotary wing rating to his pilot's license. "At the end of my first trip riding in the left [helicopter copilot] seat, I began to figure maybe I could learn to fly this thing," he says. "If you can fly an underpowered little Hiller, you can do aerobatics with an H-34, it's so powerful."

Jim Moriarty plies a grease gun during preflight of the Dog's complex rotor head, which has dozens of fittings.



He wouldn't fly the first aerobatics in a 34. "Oh yeah, they were maneuverable," laughs Joe Scholle. "I remember a guy did a couple of rolls and then looped it, for the benefit of the A-4 and F-4 pilots sitting on the beach at Chu Lai, in late '67. Of course, you don't get a real circle out of it; it looks more like a backward nine."

Moriarty has logged over 400 hours in YL-42, much of that flying to airshows. He and his crew chief, J.T. Nelson, wear full Marine flightsuits, complete with flight crew wings and HMM-362 squadron patches and insignia. At first you think *Uh oh—middle-aged men playing boy soldiers*, but in fact they do all of it out of respect for the tradition, history, and sacrifice that YL-42 represents. "One of the rules of the aircraft," Moriarty says, "is that when you fly or crew it, you wear the uniform. Not because I think it's fun but because I want to honor the people who flew them. I will *not* fly this aircraft in shorts or jeans or tennis shoes."

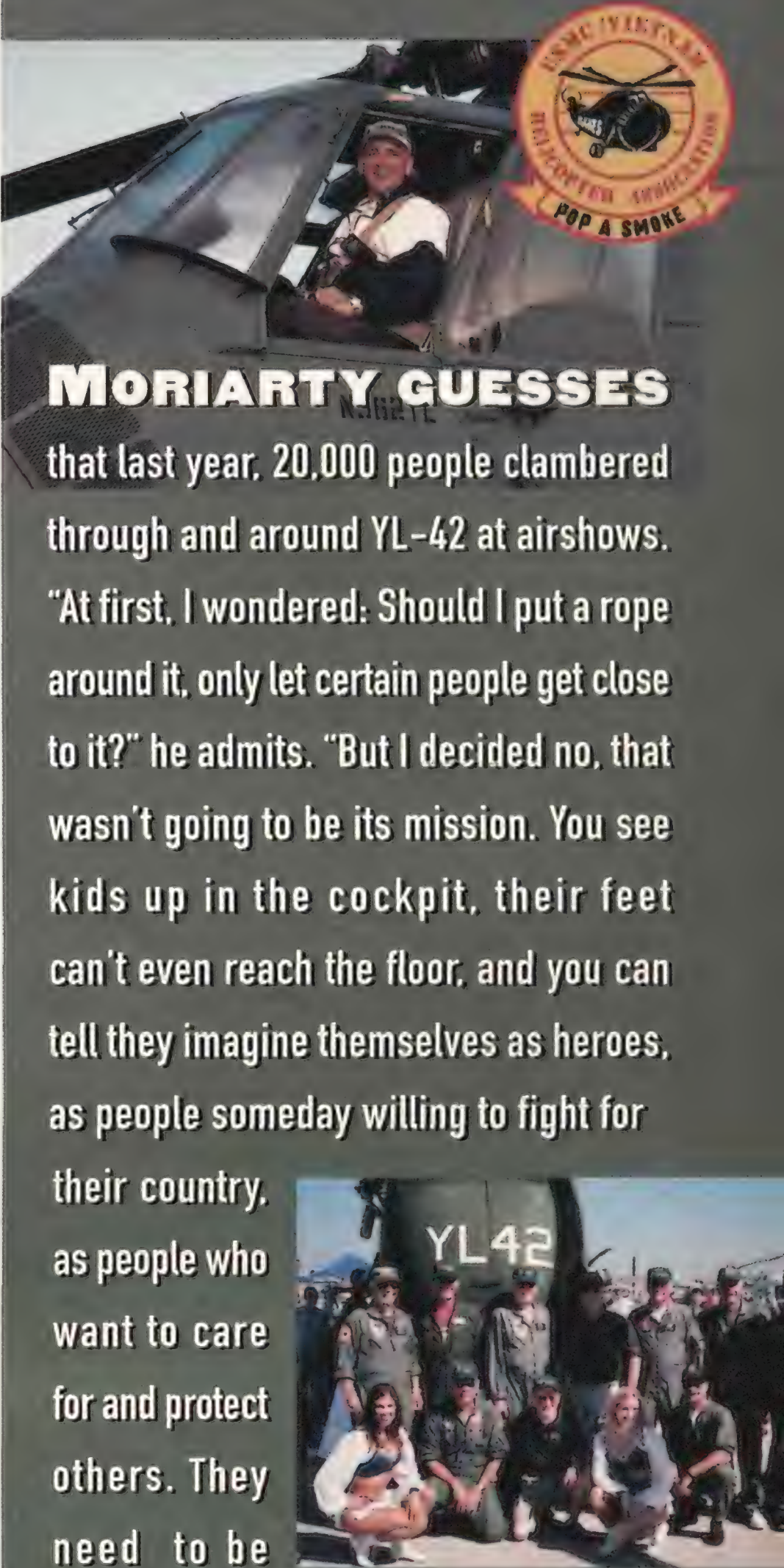
At U.S. airshows the missing link seems to be Vietnam-era aircraft, especially helicopters, say those who applaud Moriarty's effort. The aircraft attracts a crowd of people who want to see things exactly the way they used to be. Some aircraft owners charge a fee to climb into the cockpit or whatever, but not Moriarty.

One remarkable feature of his helo, although few notice it, is that all of the complex data stencils on the underside of its four rotor blades are in French: The blades are surplus parts from an Armée de l'Air H-34. Even though YL-42 is 40 years old, getting spare parts is not a problem. Various versions served with the Coast Guard and CIA as well as 25 nations—even the Soviet Union: When Communist Party Chairman Nikita Khrushchev visited President Dwight Eisenhower in 1959, before the U-2 spyplane incident soured their relations, he rode in Ike's Marine One, a UH-34D, and liked it so much that he bought two of them.

The government sold tens, even hundreds of 34s for pennies a pound, Moriarty points out. "It costs \$150,000 to \$250,000 to buy one now and make it ready for flight, and when you're done, you have an aircraft with a market value substantially less than that. All offshore [oil industry] work is twin engine, and jet choppers are far more reliable. So there's very little economic justification for keeping 34s in the air, and as a result, the hundreds of them sitting in boneyards and back yards will provide a source of parts for years to come."

Moriarty guesses that last year, 20,000 people clambered through and around YL-42 at various shows. "At first, I wondered: Should I put a rope around it, only let certain people get close to it?" he admits. "But I decided no, that wasn't going to be its mission. You see kids up in the cockpit, their feet can't even reach the floor, and you can tell they imagine themselves as heroes, as people someday willing to fight for their country, as people who want to care for and protect others. They need to be able to touch that dream."

Moriarty exhibits YL-42 not because he's trying to re-create the Vietnam War; nor is he an aviation buff or a warbird fanatic. He does it, he says, because "we lost 58,000 people over there, and all of their mothers and fathers, sons and daughters, brothers and sisters, wives and husbands still think about them all the time, and it's important that they never be forgotten." —



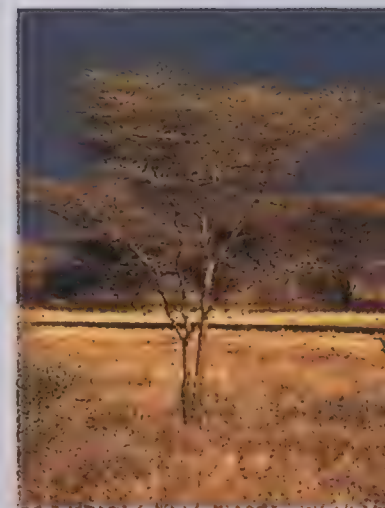
MORIARTY GUESSES
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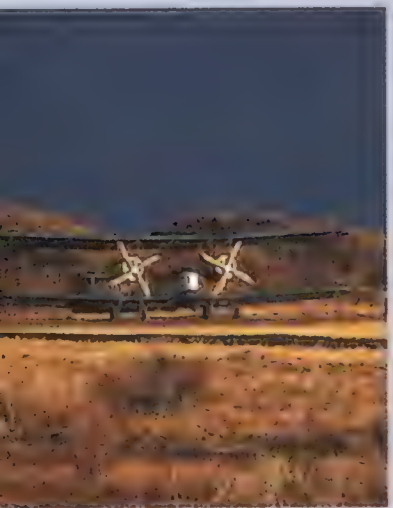
COURTESY JIM MORIARTY

With plentiful parts and a dedicated all-volunteer crew, YL-42 should be flyable for years. Its limited speed and range keep most of the helicopter's airshow appearances close to its Houston home, but a California sortie is on this summer's schedule (see www.popasmoke.com).

▶ SIGHTINGS ◀

With a 68-foot wingspan, this Vickers Vimy, a 1993 replica of the famed 1918 bomber, is the world's largest airworthy biplane. Photographer Peter McBride captured it in all its glory as its pilot and builder, John la Noue, flew it over Arizona prior to a tour of the United States (right). McBride, la Noue, and pilot Marck Rebholz had just retraced the first trans-Africa air passage, a 1920 flight Pierre van Ryneveld and Quintin Brand made from Surrey, England, to Cape Town, South Africa. While above Egypt's Nile Delta, McBride hung over the back of the bombardier's cockpit, which sits forward of the pilots' cockpit, to photograph the pilots and the right engine and wings (below). He also mounted a camera in the tail to capture the aircraft banking after takeoff from La Ferte Alias, south of Paris (bottom left). In Samburu, Kenya, darkening clouds greeted the crew (bottom right).







What They Really Said

The Mission Transcript Collection: U.S. Human Spaceflight Missions From Mercury Redstone 3 to Apollo 17.

(NASA SP-2000-4602). Two CD-ROMs for Windows or Macintosh. The CDs are free, one set per customer, as long as supplies last. Send a self-addressed padded envelope with enough postage (no cash or checks) for a standard CD jewel case—typically \$1.90 in the United States—to: NASA Headquarters Information Center, Mail Code CI-4, 300 E St. SW, Room 1H23, Washington, DC 20546-0001.

Is there anything left to say about the space program of the 1960s? The early Mercury and Apollo astronauts are pretty well tapped out—those who don't avoid interviews and anniversaries altogether just replay the same tired loop of oft-requested stories. A few

landmark books, from Tom Wolfe's *The Right Stuff* to Andrew Chaikin's *A Man on the Moon*, have supplied much-needed correctives to those one-dimensional astronaut portraits we were handed at the time. And many of the original NASA documents, including the technical debriefings the astronauts gave after their return to Earth, are finally making their way into print, notably in a series published by Apogee Books.

So have we drawn the last drop from the well? Not quite. NASA's own historians, led by Glen Swanson at the Johnson Space Center in Houston, have recently compiled—and are making available for free, in limited quantities—what may be the definitive collection for any student of the U.S. space program's glory days. Now, on two CD-ROMs, you can have every word spoken by the Mercury, Gemini, and Apollo astronauts during their historic missions—not only their exchanges with the ground, but also their less-well-known private conversations.

The latter are the real treasures in this

mammoth compilation, which runs to thousands of pages in PDF (Adobe Acrobat) format. The early NASA spacecraft had the equivalent of a cockpit recorder, which captured the voices of the crew. Unlike the air-to-ground conversations, which were broadcast live to the whole world, these were never heard by the public. Transcripts of the tapes were originally marked "confidential." Even after they were declassified, they sat collecting dust in NASA archives, read only by a few hardcore space historians. Chaikin was the first to make extensive use of the tapes, which revealed the astronauts in a new, uncensored light, complete with anxiety, amazement, and yes, occasional profanity.

Most of the talk, as you might expect, is technical. But amid the dense discussions of switch settings and star alignments is an occasional gem, such as this charming exchange between Apollo 8 astronauts Frank Borman, Jim Lovell, and Bill Anders in the moments immediately following their historic Christmas Eve reading from "Genesis" in lunar orbit:

Borman: ...And from the crew of Apollo 8, we close with good night, good luck, a merry Christmas, and God bless all of you, all of you on the good earth.

Lovell: That's it.

Borman: Don't say anymore now.

Anders: I just turned [the camera] OFF. You want it ON again?

Borman: No, leave it OFF. Great! Great!

Anders: OFF?

Borman: Yes.

Anders: Okay.

Lovell: Camera's OFF?

Anders: Yes.

Borman: Hey, how can you beat that?

Jeez, we just went into the terminator [the line between day and night] right in time.

Lovell: Okay, let's get the spacecraft back in even keel again. Here, here's this, Frank.

Borman: All right, let's get the flight plan out here.

Borman: We've got to get it.

Lovell: Okay.

Anders: Whew! Pretty impressive out there.

Borman: Boy, it sure is.

Borman: Okay, men.

Lovell: It's 86 hours.

Borman: Houston, how do you read Apollo 8?

Borman: Don't tell me they didn't hear us.

Though they are thick with acronyms and NASA-speak, these transcripts, plus the more extensive transcripts of air-to-

X-15 REPORTS

X-15: The NASA Mission Reports

edited by Robert Godwin. Apogee Books, 2000. 408 pp. \$29.99 (paperback, with CD-ROM).

An eagerly awaited addition to Apogee's series, X-15 is a reprint of actual NASA reports from the entire X-15 flight test program. Particularly interesting are emergency-procedure descriptions from the pilots' handbook and design summaries that depict the X-15 being carried by a B-36 Peacemaker, its first intended mothership. All X-15s were taken aloft by NASA's two venerable B-52s (see "Mother," p.26). Includes a CD-ROM packed with data and raw film footage.



ground conversations, also included in the CD set, make for compelling reading. It's like eavesdropping on Lewis and Clark or Magellan.

Some of the early astronauts reportedly are unhappy about having their unguarded words made available to a wider public. And who, really, can blame them? But armchair astronauts everywhere should be glad.

—Tony Reichardt is a consulting editor at Air & Space.

The Genesis of Flight: The Aeronautical History Collection of Colonel Richard Gimbel

by Tom D. Crouch et al. University of Washington Press & Friends of the United States Air Force Academy Library, 2001. 380 pp., \$60.00 (hardbound).

What do the following have in common: a 3,000-year-old Babylonian seal with wondrous carved impressions of mythic winged beings, and a bronze medal produced in 1972? Upon examining *The Genesis of Flight*, the answer quickly becomes obvious.

The 300 objects carefully chosen to fill the pages of this book were gleaned



from the 20,000-plus items in the collection of Colonel Richard Gimbel, a son of one of the founders of the Gimbel department store chain. Gimbel served in the Eighth Air Force during World War II and retired from the U.S. Air Force in 1953. He had begun collecting aviation artifacts while serving in England during the war, and after retiring, he became the curator of aeronautical literature at his alma mater, Yale University. Gimbel died in 1970, and in keeping with his wishes, his outstanding collection of memorabilia was donated to the library of the U.S. Air Force Academy in Colorado Springs, Colorado.

Gimbel's eclectic taste, broad knowledge of literature, and keen eye proved to be brilliant guides in obtaining obscure and often overlooked items relevant to the history of flight. *Genesis* covers the collection's six main themes: printed books, manuscripts, prints, numismatics, seals, and a catch-all category of other holdings. Each page contains a color photo of a highlighted object and a brief text explaining its significance.

Tom D. Crouch, senior curator at the National Air and Space Museum, wrote the book's introductory segment and selected the books from Gimbel's collection to be highlighted. The books were printed between 1851 and 1914, a period that runs from the later balloon flights of the 19th century to the earliest powered aircraft. Within this period we find the musings of science fiction writer Jules Verne, glider pioneer Otto Lilienthal, and other notables, like Octave Chanute.

The printed texts from earlier periods are treasures, and include religious tracts, philosophical musings, speculations on the nature of the universe, and accounts of actual and fictional flights, such as Jean-Pierre Blanchard's description of his 1793 flight and George Fowler's fanciful "A Flight to the Moon," written in 1813. Gimbel's collection includes noted works by Johannes Kepler, Lucianus Samosatensis, Francesco Lana de Terzi, Robert Hooke, and Barthelemy Faujas de Saint-Fond.

In *Genesis*' "Other Holdings" section, ephemera of all sorts, from sheet music to china plates, are detailed by Dominick A. Pisano, NASM's aeronautics department chairman. There are some fun pieces, including a florid poem penned by balloonist Charles F. Durant in 1833: "...Farewell! Farewell! I leave behind Earth and its gazing crowd,/To seek the fountain of the wind,/The birthplace of the cloud."

Included with this superbly printed

book is a well-executed CD-ROM. You have two options: a brief but excellent tour or survey, presented as an audio-visual collage, or a more conventional point-and-click viewing of all the book's images, accompanied by the explanatory text in the book. The disk contains a virtual magnifying glass that provides a better view of the collection's objects.

All told, the catalogue meets its intended purpose—to disseminate a sampling of the memorable items in the Gimbel collection. *Genesis of Flight* contributes greatly to our understanding of the historical and cultural aspects of traveling aloft.

—Carl Bobrow is a former Alfred Verville Fellow at the National Air and Space Museum.

Cassada

by James Salter. Counterpoint, 2000. 208 pp., \$25.00 (hardbound).

James Salter's most recent novel is a rewrite of his 1961 novel *The Arm of Flesh*. Though that work was acclaimed, it was, according to Salter, a poor seller. Salter, a West Point graduate and fighter pilot who served in Korea, knows his subject and is one of today's most universally admired literary fiction writers. In a brief foreword to *Cassada*, he asserts that *Arm* "had serious faults and needed to be rewritten completely," unlike his first Korean air war novel, *The Hunters*, which was republished in 1997

with only minor revisions.

The title comes from the name of one of the principal characters in both the old and new novels. Although both *Cassada* and *Arm* are told in fragmented pieces through the eyes of a variety of characters, in *Cassada* the storyline flows smoother and the characters are somewhat more defined.

The book is set at an unnamed U.S. fighter base in Germany. The time is the mid-1950s, and this is the place for a fighter pilot to be. The older pilots in the squadron are veterans of the Korean war, secure and competent in their positions. The story focuses on Lieutenant Cassada—a "new guy" in a fictitious squadron—and his efforts to fit in.



Salter brilliantly reveals the politics at work in a unit of men with strong wills and egos who are executing a challenging peacetime mission. *Cassada* unfolds through a series of

flashbacks told from the perspectives of pilots, squadron wives, and complete strangers, all aimed at revealing the forces at play in the squadron while building the tension of the present scenes and filling in the past. The story reaches its climax as the squadron commander—who rules his unit like a feudal lord and treats his pilots as knights errant—worries so much about the future of his career that he ignores any other concerns. Meanwhile, Cassada—a tea drinker among boisterous, coffee-drinking pilots—strives to prove himself. With its vivid storytelling, *Cassada* is a further polishing of an already superb Salter work.

—Lieutenant Colonel Bob Hanson, U.S. Air Force (ret.), flew fighters from the mid-1950s to the mid-1970s.

A War to Be Won: Fighting the Second World War

by Williamson Murray and Allan R. Millett. Belknap/Harvard University Press, 2000. 656 pp., campaign maps, b&w photos. \$35.00 (hardbound).

"World War I provided considerable experience for airmen to mull over, had they been so inclined." This sentence is typical of the authors'

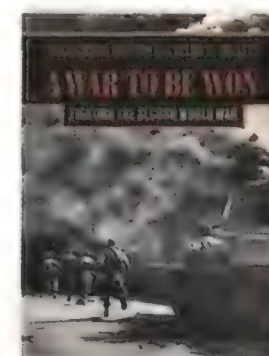
approach: Williamson Murray and Allan R. Millett are scholars, but they're not adverse to putting a barb in their judgments.

Of course, I turned first to the chapters on the air war. "The received postwar wisdom suggests that strategic bombing played a relatively unimportant part in winning World War II," the authors point out—after demonstrating that the received wisdom is wrong. City-busting began with Hitler's 1941 order to destroy Belgrade "from the air by continual day and night attacks." Two years later, Germany reaped the whirlwind, beginning with the incineration of Hamburg. By the summer of 1943, Germany was losing 16 percent of its defending fighter pilots every month, and by year's end had written off 141 percent of its average fighter-pilot strength. Allied losses were worse, but the United States was at least able to send in more and better-trained men each year.

Altogether, the Anglo-American bombing offensive was so successful it qualified as the "second front" demanded by the Soviet Union and its propagandists in the United States. And a bloody front it was: Rather than fly for the Eighth Air Force, an American would have had a better chance of surviving the war by joining the Marines and fighting across the Pacific. And a German pilot flying over the Reich was at greater risk than a Waffen SS trooper on the eastern front. The defenders' desperation is exemplified by their deployment of 10,000 flak cannon against Anglo-American bombers and only 8,200 against Russian tanks.

Without pilots, gasoline, or transportation, the German war machine was collapsing by January 1945 and so could not defend the homeland in the promised

Götterdämmerung; thus, thousands of lives on both sides were spared. The authors' final judgment on the Allied bomber offensive: "It was not elegant, it was not humane, but it was effective."



The air war over Germany was only a small part of the global catastrophe of 1937 through 1945. The authors treat land and sea campaigns in North Africa and Asia

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equally, moving from one to another in a narrative that flows as easily as a novel.

No better one-volume history of World War II has ever been written. This book belongs in the library of anyone with the slightest interest in the most terrible event of the century just past, if not all of human history.

—Frequent contributor Daniel Ford is Webmaster of www.danford.net, a site devoted to military history.

An Airman's Odyssey: Walt Braznell and the Pilots He Led Into the Jet Age

by William Braznell. University of Missouri Press (573-882-7641), 2001. 229 pp., \$34.95 (hardbound).

Like a doctor beginning his practice as the first antibiotics are being introduced or a young computer engineer working on the first desktop machine, Walt Braznell experienced the dawn of an epoch: He began his career hauling mail in fragile World War I-surplus biplanes and ended it flying modern jet transports like the Boeing 707.

The text of *An Airman's Odyssey*,

written by Braznell's son, former Air Force pilot William Braznell, is punctuated by the elder Braznell's original words, taken from taped interviews and diaries. Through these generously



quoted passages we get an inside look at the creation of the commercial airline industry, as aircraft, navigation, and flight control technology advanced rapidly between the 1920s and 1960s.

Along the way, we're entertained by Braznell's many yarns, such as his tale of flying Curtiss Condors for American Airways on midnight sleeper service in the early 1930s. Departure time was midnight, but the passengers boarded the aircraft two hours earlier as it sat in its hangar. The mechanics whispered as they completed their work, and then the Condor, with its load of sleeping occupants, was pushed quietly onto the ramp.

Braznell and his copilot went through their preflight checks with hand signals. All was peaceful until the engine start switches were thrown,

BRITISH AVIATION

V-Force: Britain's Airborne Nuclear Deterrent

by Robert Jackson. Ian Allen Publishing (order through Combined Publishing: 800-418-6065), 2000. 160 pp., \$34.95 (hardbound).

History of the Royal Air Force's early nuclear-armed strategic bombers, before Britain's nuclear attack role was completely taken over by submarines.

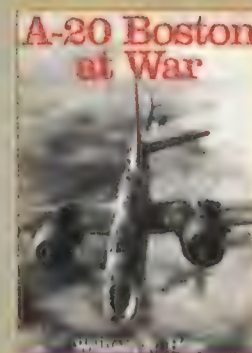


A-20 Boston at War

by William N. Ness. Ian Allen Publishing (order through Combined Publishing: 800-418-6065), 2000. 128 pp., \$34.95 (hardbound).

Known to Yanks as the Havoc (a name actually coined by the Royal Air Force that was adopted by the U.S. Army Air Forces), the A-20 was a

rugged light bomber which begat the P-70 night fighter. Ness' book has been out of print, but this new edition is available in the United States.



Bomber Command 1939-45: Photographs from the Imperial War Museum

by Ian Carter. Ian Allen Publishing (order through Combined Publishing: 800-418-6065), 2000. 160 pp., b&w photos, \$34.95 (hardbound).

A great collection of archival photos—many never before published—of such craft as the Short Stirling and Avro Lancaster, as well as their crews.



Handley Page Victor

by Andrew Brookes. Ian Allen Publishing (order through Combined Publishing: 800-418-6065), 2000. 128 pp., \$24.95 (hardbound).

The distinctive-looking Victor was first flown in 1952. Designed as a nuclear bomber, during its long career it was eventually relegated to tanker duty.



Lincoln at War: 1944-1966

by Mike Garbett and Brian Goulding. Ian Allen Publishing (order through Combined Publishing: 800-418-6065), 1999. 176 pp., b&w photos, \$34.95 (hardbound).

The Lincoln was a development of Britain's Avro Lancaster. This book was first published in 1979, reprinted in 1999, and is now distributed in the United States. Check out the contents page, which features a Lincoln "beating up" its home airfield with an eight-foot-high pass. And just for fun, the pilot did it with three of the aircraft's four propellers feathered.

resulting in backfiring "loud enough to shatter window panes." As the terrified passengers awoke, the aircraft started "flopping up and down in sync with the firing and repeated backfiring of each cylinder.... Every night we put on this tippy toe routine, not just once, but three times—Chicago, Detroit, and Buffalo—and always with the same glorious finale...."

The photographs are a treat as well. We see one of Braznell's airmail colleagues—a then-unknown pilot named Charles Lindbergh—striking a heroic pose in the cockpit of his Boeing 40B-4 biplane. And there's a 1920s aerial photo of two small hangars sitting in an open field dotted with

tents, a foreshadowing of Lambert St. Louis International Airport, today the bane of hub-and-spoke air travellers criss-crossing the Midwest. Another photograph shows Clark Gable lookalike Braznell flying the line for American. We also see a grayer but no less dashing Braznell in a mockup of a Douglas DC-8 cockpit late in his career, during which he served as the airline's chief pilot and vice president.

You've probably never heard of Walter Braznell, but that won't blunt your enjoyment of *An Airman's Odyssey*, a charming tribute from son to father.

—John Sotham is an associate editor of *Air & Space*.

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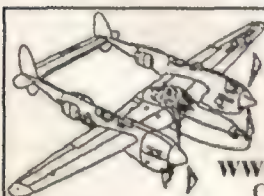
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CREDITS

Cover. Aviation photographer Jim C. Ross has logged more than 300 hours in six types of aircraft—the F-15, F-16, F/A-18, T-34, T-38, and KC-135.

Launch the Fleet! Russell Gregory has over 1,800 hours, with over 300 of them in combat operations, flying F-15s during a 10-year Air Force career. He recently traded in his aviation sports car to become a full-time bus driver. He now flies for a major airline out of New York City.

The Little Steel Strike Airlift. Robert G. Pushkar is a freelance writer and photographer in Wakefield, Massachusetts, with a special interest in history.

Fallen Star. Anatoly Zak is a freelance journalist who has been covering the Soviet/Russian space program since the end of the 1980s. A native of Moscow, he worked as a space reporter for the city's daily newspaper and currently lives in New Jersey, where he publishes RussianSpaceWeb.com, an online publication on the history of and present developments in the Russian space program.

Mother. Preston Lerner is a Los Angeles-based writer. He says his ride in 008 was the most exciting—and brutally uncomfortable—assignment he's undertaken for the magazine in 12 years.

Reading the Wreckage. Eric Adams is an associate editor at *Air & Space/Smithsonian*.

Restoration: Homecoming. J. Douglas Hinton flew jet fighters in the Royal Canadian Air Force.

Fade to Black. J. Kelly Beatty is senior editor of *Sky & Telescope*, a magazine he has worked at since 1974—about the same time IMP 8 entered service.

The Detroit Airlift. Writer and pilot Mark Huber lives in Michigan.

Dog of War. Stephan Wilkinson wrote a series for *Air & Space* about the homebuilt airplane he assembled in his barn. The same barn recently gave birth to a restored Porsche. Author and car are doing fine.

More information about photographers whose pictures appear in this issue can be found on the World Wide Web at www.airspacemag.com.

CALENDAR

June 2

EAA Chapter 690 Fly-In Pancake Breakfast. Sport Aviation Center, Briscoe Field, Lawrenceville, GA, (770) 613-9501.

June 15–17

Gathering of Eagles Airshow. Hampton Roads Executive Airport, Chesapeake, VA, (757) 855-0022.

June 16

EAA Chapter 255 Fly-In Pancake Breakfast. Harlan Airfield, Lagrange, OH, (440) 355-6491.

June 16 & 17

Deke Slayton Airfest. La Crosse, WI, (608) 779-9994.

June 23 & 24

Arnold Engineering Development Center 50th Anniversary Airshow. Tullahoma Tennessee Airport, (931) 454-3000.

High Country Warbirds Air Display. Valle-Grand Canyon Airport, AZ, (520) 635-1000.

July 4

Aransas County Fourth of July Airshow. Aransas County Airport, TX, (361) 729-6201.

July 7

Nevada County AirFest. Nevada County Airport, Grass Valley, CA, (530) 273-1972.

July 8–14

American Navion Society Fly-In and Convention. St. Simon Island, GA, (410) 692-6334.

July 14

Reunion: Kaye Field/Columbus Army Flying School, 1941 to present. Columbus Air Force Base, MS, (662) 434-7068.

July 14 & 15

Gathering of Eagles Airshow. Lost Nation Airport, Willoughby, OH, (440) 943-0084.

History of Flight Airshow. Geneseo Airport, NY, (716) 243-2100.

July 21

Fly-In Whitefish Boil. Hosted by the Washington Island Lions Club. Washington Island Airport, WI, (920) 847-2770.

July 21 & 22

Challenge on the Prairie Air Show. Central Illinois Regional Airport, Bloomington, IL, (309) 661-6546.

Dayton Airshow. Dayton International Airport, OH, (937) 898-5901.

July 27–29

Reunion: VR52/62 Detroit. Port Clinton, OH, (727) 862-6343.

FORECAST



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The only operational supersonic transport may resume service in August.

In the Wings...

Should the Concorde Fly Again?

The investigation into the fatal accident that grounded the Concorde last July will soon be complete. Ordered modifications are being flight tested, and British and French transportation ministers say service will soon resume. But a group of retired Concorde pilots and flight engineers, as well as aviation experts here and abroad, aren't so sure it should.

An Air & Space/Smithsonian Guide to Airplane Watching

Airports where the view from the fence is as good as it gets.

Old Friends

A World War II bomber pilot, his fighter escort, and one whopper of a coincidence.

Stupid Plane Tricks

Do NOT try these at home.

Live! From Earth Orbit! It's...

That space station show? How will NASA respond to the growing group of broadcasters and media moguls elbowing for access to public facilities, chief among them the International Space Station?

The First Bizjet in China

What's a nice capitalist symbol like a Cessna Citation doing in a communist country?

ON THE WEB SITE

www.airspacemag.com



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Remembering the Halifax

The Avro Lancaster may be the most famous of the Royal Air Force's World War II heavy bombers, but the Handley Page Halifax shouldered a large share of the night missions against Germany and also parachuted agents and arms to European resistance movements. For photographs and stories of the Halifax missions, visit the Web.

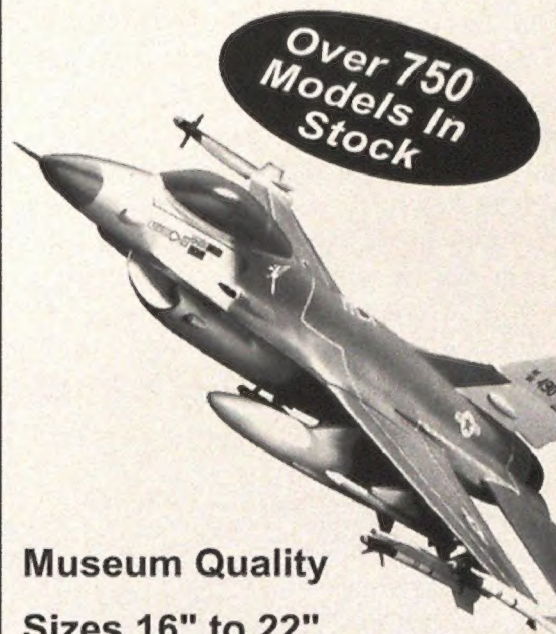
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Boeing Unveils "Sonic Cruiser"

Farther, faster, and quieter—as opposed to bigger—are the capabilities that the Boeing Company says it is seeking in the next generation of airliners.

Amid speculation as to where the company is going with product development, President Alan Mulally recently announced that his design team is focusing on a "sonic cruiser" that could operate above 40,000 feet at Mach .95 or greater over a range of 10,350 miles.

On the surface, such claims are outside the range for existing technology, given the aerodynamic problems an aircraft encounters as it approaches Mach speeds. The fully loaded Concorde, for example, can routinely operate at Mach .95, but only over ranges of roughly 3,200 miles. Vice President for Business Strategy and Development Michael Bair says Boeing is gearing up to address the technical

747X aircraft that could compete in the market for high-capacity transports (500 to 600 passengers). Instead, the sonic cruiser would target an altogether different category, seating 225 passengers, although some airlines are asking Boeing to consider a version carrying 250 to 300 passengers.

The sonic cruiser has canards and double-delta wings supporting twin engines. Responding to observations that the aircraft is suggestive of stealth technology, Boeing acknowledges that the design borrows from military craft—the XB-70 comes to mind.

The speed of the transport would cut transatlantic flight times by at least two hours, and trans-Pacific flights three hours, reducing operating costs and creating more revenue opportunities for operators. The airlines are likely to place the aircraft in service to city pairs that make the best use of its speed, and some routes currently unserved could open up as a result of the new math.

By building a quieter long-range airplane, Boeing also hopes to give carriers a way to get around curfews and to schedule routes for speed. Carriers flying long distances face the dilemma of scheduling takeoffs and landings within noise restrictions at widely separated points. What is acceptable upon takeoff may be

wholly unacceptable upon landing. The low-noise profile of the new airplane would partly derive from a high climb rate and a high thrust-to-weight ratio.

—Stuart Nixon



BOEING

issues inherent in the new design and sees "a very high probability" that the program will go forward. The company estimates that the aircraft could enter service between 2006 and 2008.

The new airplane would be a radical departure from Boeing's "derivatives" philosophy—stretching or otherwise redesigning its 747, 767, and 777 products. In particular, the company says it is backing off from concentration on a

LOGBOOK

Awards

In recognition of the top aeronautical achievement in the United States during 2000, the Collier Trophy has been awarded to Northrop Grumman, Rolls-Royce, Raytheon Company, L-3 Communications, the United States Air Force, and the Defense Advanced Research Projects Agency for designing, building, testing, and operating Global Hawk—the first fully autonomous, operationally demonstrated, and most capable surveillance and reconnaissance Unmanned Aerial Vehicle in the world. It performs high-altitude, long-endurance, and hazardous missions without putting pilots at risk. The Collier Trophy was presented to the winning team early last May in Washington, D.C. It is named for the first person to buy an airplane from the Wright brothers for personal use.

Call for Nominations

Nominations are due on August 31 for the 2001 Wright Brothers Memorial Trophy. Established in 1948, the trophy is presented annually to a living American for significant public service of enduring value to aviation in the United States. (The 2000 trophy was presented to Herb Kelleher, president of Southwest Airlines.) The trophy will be presented in Washington, D.C., in December.

Records

The 2001 Edition of the World and United States Aviation and Space Records is now available. For more information, visit www.naa-usa.org.

Certificates

Raytheon Aircraft's new Premier I business jet has been awarded type certification by the Federal Aviation Administration. The Premier I is an entry-level design and the first composite-fuselage business jet to be FAA-approved. Raytheon says the aircraft will have the fastest cruise speed (530 mph) and the largest six-passenger cabin in its class.

Moments & Milestones is produced in association with the National Aeronautic Association. Visit the NAA Web site at www.naa-usa.org or call (703) 527-0226.

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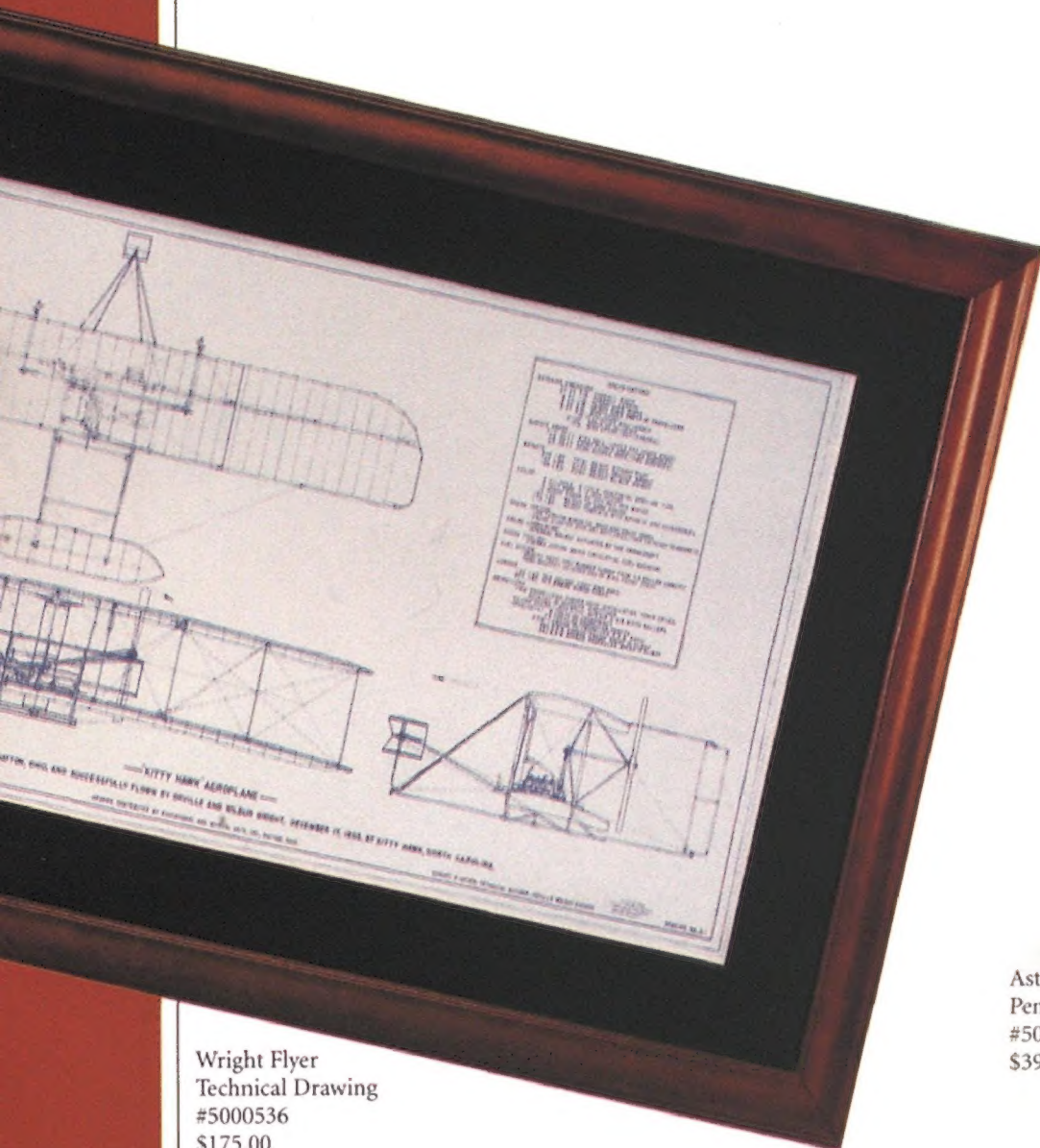
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